

THE HIGH SPEED ELECTRONICS GROUP

Microwaves & RF

News

Analog circuit
hikes PA efficiency

Design Feature

Meld load-pull tests
with EDA tools

Product Technology

Capacitor supplier
turns to TCXOs

On-Wafer Probes Test Si ICs To 110 GHz

Wireless
Technology
Issue

Infinity Probe™

Infinity Probe™

#BXNPGNX *****AUTO**3-DIGIT 543
#533579017 5# RF 001 100 SCK 510



JOE LORITZ, ENGINEER
GBPPR
424 WILSON AVE
GREEN BAY

WI 54303-4115

CASCADE
MICROTECH

THE FAMILY THAT MEASURES UP |||||



SITE MASTER®

The proven leader in handheld cable and antenna system analyzers that technicians have come to trust.



SPECTRUM MASTER™

The ideal on-site survey and testing tool, providing spectrum analysis anywhere, anytime.



CELL MASTER™

The ultimate tool for cell site technicians providing complete antenna, cable, and base station analysis.

Introducing application specific solutions for the RF and Microwave Field Testing Industry

Field proven leader of application specific Handheld RF and Microwave Analyzers now provides a family of handheld solutions for all of your cell site needs. Once again, Anritsu has set the standard with this array of application specific solutions.

- Field Proven
- Rugged
- Less than 5 lbs.
- Easy-to-Use
- Anritsu Quality

When you need Anritsu precision and quality in a field friendly solution call 1-800-ANRITSU, or check

www.us.anritsu.com/family/126



A Family of Measuring Tools

Sales Offices: USA and Canada 1-800-ANRITSU, Europe +44-1582-433433, Japan 81(03)3446-1111, Asia-Pacific 65-2822400, South America 55(21)527-6922, www.us.anritsu.com ©2003 Anritsu Company.

Anritsu

Discover What's Possible®

#1 OVERALL PERFORMANCE

11 Years in a Row!

How do you measure performance? How about letting your customers do it for you! For the eleventh straight year, Digi-Key has been rated #1 among electronic component distributors based on the Distributor Evaluation Study conducted by Beacon Technology Partners, LLC, 2002.



www.digikey.com

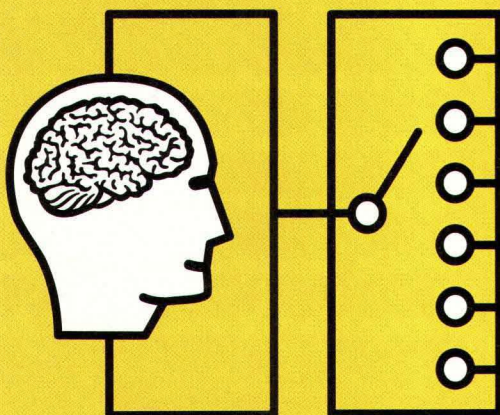
1.800.344.4539

Fax: 218.681.3380

© 2003 Digi-Key Corporation

NEW GaAs MMIC SWITCHES.

ONCE YOU'VE SEEN THEM, YOU MAY
**WANT to RETHINK
YOUR DESIGN.**



- Bandwidth to 6 GHz for 802.11 a, b, g
- Low Height Profile Packages, as low as 0.55 mm
- Low Voltage Operation, as low as 1.8 Volt
- High Power Handling Capability, to +36 dBm
- Embedded Converters for Single Pin Control
- Multiple Throw Architectures

For information and data sheets, visit
www.cel.com/switches.asp

CEL California Eastern Laboratories

Santa Clara, California ■ 408 988-3500

NEC

A Business Partner of NEC Compound Semiconductor Devices, Ltd.
NEC is a trademark of NEC Corporation.

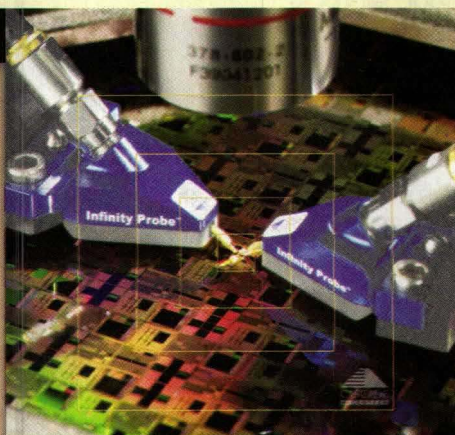
DISTRIBUTORS: Arrow (800) 525-6666 Repton Electronics (888) 737-8766
Mouser Electronics (800) 346-6873

Microwaves & RF

A Penton
PublicationVisit us at www.planetEE.com

Departments

- 13 Feedback
- 17 Editorial
- 21 The Front End
- 38 Editor's Choice
- 40 Financial News
- 43 Company News
- 44 People
- 46 Educational Meetings
- 48 R&D Roundup
- 82 Application Notes
- 106 New Products
- 111 Infocenter
- 112 Looking Back
- 112 Next Month



COVER STORY

84 On-Wafer Probes Test Silicon ICs To 110 GHz

Thin-film lithographic technology helps to define the precise features of probes with the low contact resistance needed to accurately characterize emerging silicon-based high-frequency devices.

News

- 33 Linearizer Hikes PA Efficiency

Design

- 51 Meld Load-Pull Tests With EDA Tools
- 75 Reducing ESR Measurement Errors

Product Technology

- 92 Veteran Cap Supplier Unleashes New TCXOs
- 94 Compact DDS Silences Spurious And Phase Noise
- 102 4 x 8 Switch Matrix Serves Smart Antennas

Visit us at PlanetEE.com

Penton Electronics Group's website at www.PlanetEE.com offers a variety of options for engineers. Think of it as a gateway to design information in all areas of electronics, from components to systems. Use it to discuss a favorite topic with top magazine editors at the PlanetEE Discussion boards (www.PlanetEE.com/forums). Comb through current and archived issues of leading electronics magazines, such as *Microwaves & RF*, *Wireless Systems Design*, *Electronic Design*, and *EE Product News*. Search for products and specifiers in two top on-line directories: *Microwaves & RF's* Product Data Directory Online and *EE Product News's* Product Locator. Learn more about electronic-design trade shows, such as Wireless Systems Design Conference and Expo 2003. Or sign up for an informative E-Newsletter, on topics ranging from EDA to Wireless Networks. All this in just one web page. Just add www.PlanetEE.com to your browser's list of "favorites."



SUBSCRIPTION ASSISTANCE AND INFORMATION:

Microwaves & RF (ISSN 0745-2993) is published monthly, except semi-monthly in December. Subscription rates for US are \$80 for 1 year (\$105 in Canada, \$140 for International). Published by Penton Media, Inc., The Penton Building, 1300 E. 9th St., Cleveland, OH 44114-1503. Periodicals Postage Paid at Cleveland, OH and at additional mailing offices.

Canada Post International Publications Mail (Canadian Distribution Sales Agreement Number 344311). CAN. GST #R126431964. Mail your subscription requests to: *MICROWAVES & RF*, P.O. Box 2095, Skokie, IL 60076. POSTMASTER: Please send change of address to: *MICROWAVES & RF*, P.O. Box 2095, Skokie, IL 60076.

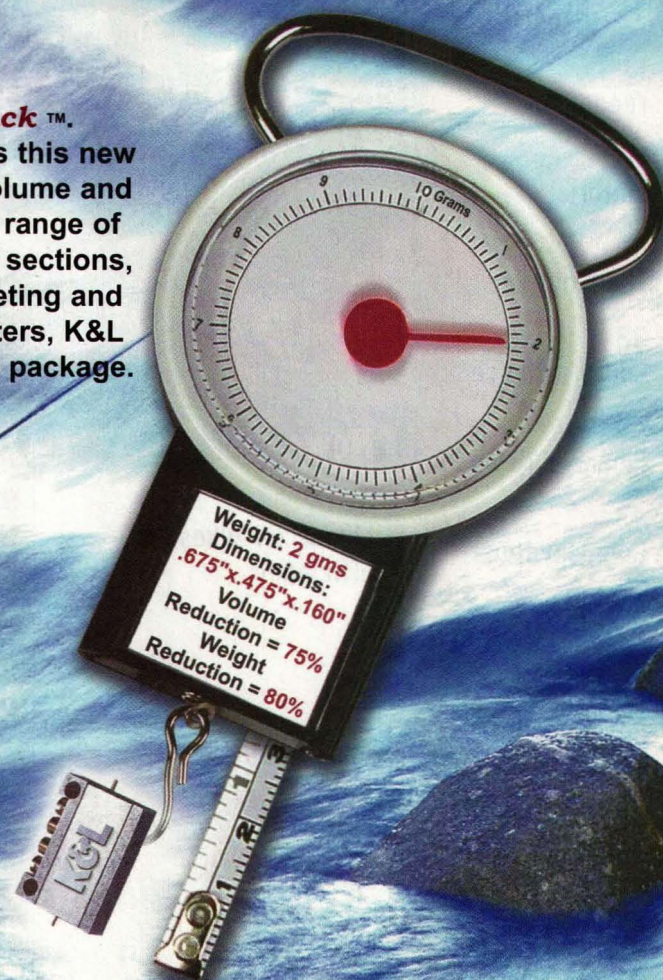


A **DOVER** COMPANY

Mini-Pack™

Minimum Size — Complete Package

K&L Microwave introduces its new *Mini-Pack*™. Compared to standard combines or interdigitals this new cavity filter offers considerable reductions in volume and weight. The *Mini-Pack*™ is available in a wide range of frequencies from 6 GHz to 18 GHz with up to 10 sections, making it ideal for military applications. By meeting and exceeding the requirements of most military filters, K&L is offering maximum performance in a complete package.



Weight: 2 gms
Dimensions:
.675"x.475"x.160"
Volume
Reduction = 75%
Weight
Reduction = 80%

Sometimes SIZE Is Everything

Filtering Solutions for Your Global Market

Visit us online at www.klmicrowave.com

USA: 410-749-2424 * sales@klmicrowave.com * UK: 44-(0)-1908-224746 * sales@kleurope.com

MCE / WEINSCHEL PROGRAMMABLE ATTENUATORS

Products That Make a World of Difference

Your Source for Programmables...

From our new solid-state series to designing complex attenuation matrixes, Weinschel offers a wide selection of Programmable Attenuators that make a world of difference in your test or subsystem applications.

Relay Switched (3200 & 150 Series)

- Choice of frequency Ranges (dc-1, 2, 3, 4, 18, & 26.5)
- Optional TTL Drivers & SmartStep™ Models
- 3200 Series; Options for Frequencies to 3 GHz & higher
- Phase Compensated & 75 Ohm Designs
- Latching & Non-Latching Designs
- Custom designs our specialty!

Model No.	FREQ (GHz)	ATTN (dB)	Cells
3200-1	dc-2.0	127/1	8 * *
3200-2	dc-2.0	0.63.75/.25	8 * *
3201-1	dc-2.0	31/1	5 * *
3201-2	dc-2.0	120/10	5 * *
3201-4	dc-2.0	1.2/1	5 * *
3205-1	dc-2.0	70/10	5 * *
3205-2	dc-2.0	55/5	5 * *
3205-3	dc-2.0	1.5/1	5 * *
3206-1	dc-2.0	63/1	6 * *
3209-1	dc-2.0	64.5/0.1	10 * *
3250-63	dc-1.0	63/1	6 * *
150-11	dc-18.0	11/1	4 * *
150-15	dc-18.0	15/1	4 * *
150-31	dc-18.0	0-31/1	5 * *
150-62	dc-18.0	62/2	5 * *
150-70	dc-18.0	70/10	3 * *
150-75	dc-18.0	75/5	4 * *
150-110	dc-18.0	110/10	4 * *
152-55	dc-26.5	55/5	4 * *
152-90	dc-26.5	90/10	4 * *

* Available with SmartStep™ Control Circuitry

➤ Optional frequency ranges available, use 151 for dc-4.0 & 152 for dc-26.5 GHz

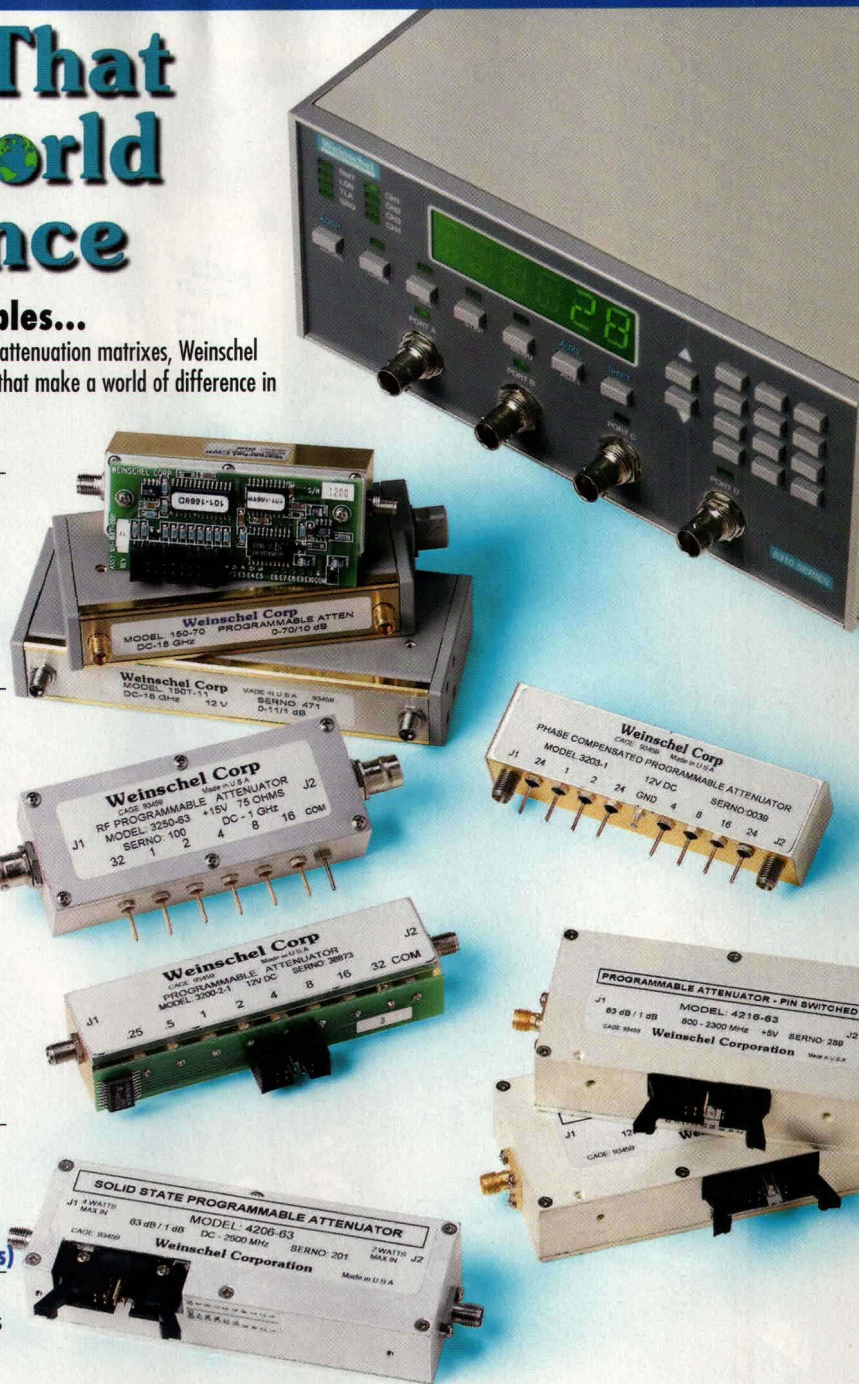
◆ 3 GHz Designs Available, * 75 Ohm Model

Attenuator Units (8310, 8311 & 8312 Series)

- Provides a flexible, easy to program, low cost solution for bench test/calibration setups and subsystem applications
- Multi-Channel attenuation paths (up to 8 input/outputs)
- Relative vs. Nominal attenuation step function
- Wide choice of Frequency & Attenuation Ranges
- 100 Watt Hot-Switchable, 0-15/31 in dB Steps
- Designed to interface with all SmartStep™ Components and other electromechanical devices
- Controlled by industry standard communication interfaces:
 - GPIB/IEEE-488 (HS-488 ready)
 - RS-232, RS-422, RS-485



Certificate No. 94-2890



New Solid-State Switched (4200 Series)

- Designed for Wireless/Cellular RF Simulation & Test Applications
- Pin & GaAs Switched Designs
- High IP3 & Higher Power Designs
- Special Configurations Available!

Model No.	FREQ (GHz)	ATTN (dB)	Cells
4206-63	0.01-2.5	63/1	6
4208-63.75	0.01-2.5	63.75/.25	8
4216-63	0.8-2.3	63/1	6
4218-63.75	0.8-2.3	0.63.75/.25	8
4218-127	0.8-2.3	127/1	8
4226-63	0.8-3.0	63/1	6
4228-63.75	0.8-2.5	0.63.75/.25	8
4238-103	0.8-3.0	103/1	8
4238-63.75	0.01-2.5	0.63.75/.25	8
4238-103	0.01-2.5	103/1	8

MCE

WEINSCHEL

5305 Spectrum Drive, Frederick, Maryland 21703-7362
 800-638-2048 • Tel: 301-846-9222 • Fax: 301-846-9116
 e-mail: sales@weinschel.com • Web: www.weinschel.com



Coaxial Components

for your microwave, wireless or broadband applications, DC - 50 GHz

MCE

INMET

ISO 9001
CERTIFIED



You can count on Inmet for dependable, quality-made components. There are over 3,000 variations of precision and low cost products including attenuators, terminations, in-series and between-series adapters, dc blocks, bias tees and gain equalizers.

See the complete product line, and data sheets at www.inmetcorp.com.



Call 888-244-6638 or 734-426-5553 • Fax: 734-426-5557

DIRECT MODULATION MICROWAVE FIBER OPTIC LINKS

.01-3 GHz, .1-6 GHz, .1-11 GHz

FEATURES:

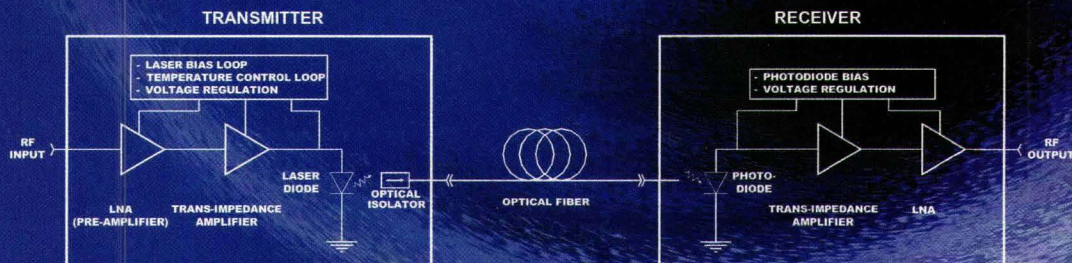
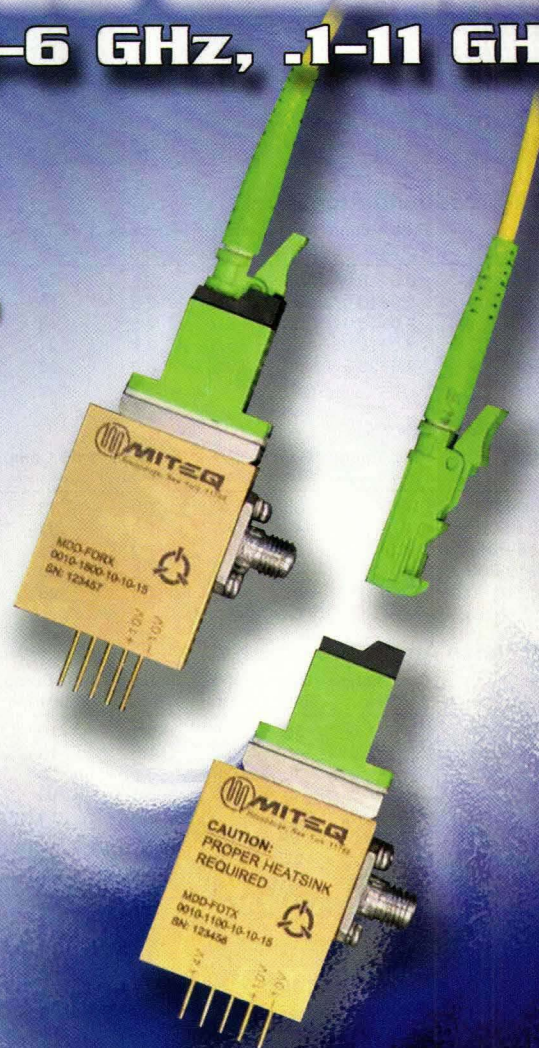
- Three Available Bandwidth Options
- Small Size
- Low Noise Figure
- No External Control Circuits Required
- Custom Configurations Available

APPLICATIONS INCLUDE:

- EMC Testing
- Antenna Remoting
- Local Oscillator Remoting
- Interfacility Communication Links

Electrical Specifications
(1 Meter of Fiber)

Model	LBL	SCM	MDD
Frequency (GHz)	.01-3	0.1-6	0.1-11
Gain (dB)	10-20 (17 Typ.)	10-20 (18 Typ.)	10-20 (18 Typ.)
Noise Figure (dB, Max.)	15 (10 Typ.)	20 (14 Typ.)	20 (18 Typ.)
Group Delay (ns ptp, Typ.)	0.1	0.1	0.1
VSWR (In/Out)	2:1	2:1	2:1
Phase Noise (dBc, Typ.)	>100	>100	>100
Input Power @P1dB (dBm, Min.)	-14	-14	-14
Spurious Free Dynamic Range (dB/Hz Min.)	100 (105 Typ.)	101 (103 Typ.)	100 (104 Typ.)



Visit www.miteq.com/folink for further information or contact
Dan Sundberg at (631) 439-9269 or dsundberg@miteq.com



100 Davids Drive • Hauppauge, NY 11788
TEL.: (631) 436-7400 • FAX: (631) 436-7430

www.miteq.com

AMPLIFIERS FOR EVERY APPLICATION

- Custom built to order
- Delivery in 2 weeks ARO
- Competitive pricing
- Military reliability

RELOCATION COMPLETE!

- ISO 9001 certified
- 100+ years design experience
- New and improved products

Ultra Broadband Amplifiers

Model	Freq. Range GHz	Gain dB min	N/F dB max	Flatness +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Current mA
JCA018-204	0.5-18.0	25	4.0	2.5	10	20	2.0:1	300
JCA218-506	2.0-18.0	35	5.0	2.5	15	25	2.0:1	400
JCA218-507	2.0-18.0	35	5.0	2.5	18	28	2.0:1	450
JCA218-407	2.0-18.0	30	5.0	2.5	21	31	2.0:1	500
JCA220-209	2.0-20.0	20	6.0	3.0	20	30	2.0:1	500

Power Amplifiers

Model	Freq. Range GHz	Gain dB min	N/F dB max	Flatness +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Current mA
JCA12-P01	1.35-1.85	35	4.0	1.0	33	41	2.0:1	1000
JCA34-P02	3.1-3.5	40	4.5	1.0	37	45	2.0:1	2200
JCA56-P01	5.9-6.4	30	5.0	1.0	34	42	2.0:1	1200
JCA812-P03	8.0-12.0	40	5.0	1.5	33	40	2.0:1	1700
JCA1218-P02	12.0-18.0	22	4.0	2.0	25	35	2.0:1	700

Low Noise Amplifiers

Model	Freq. Range GHz	Gain dB min	N/F dB max	Flatness +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Current mA
JCA12-1000	1.2-1.6	25	0.8	0.5	10	20	2.0:1	80
JCA12-3001	1.0-2.0	40	0.8	1.0	10	20	2.0:1	200
JCA23-302	2.2-2.3	30	0.8	0.5	10	20	2.0:1	80
JCA34-301	3.7-4.2	30	1.0	0.5	10	20	2.0:1	90
JCA78-300	7.25-7.75	27	1.2	0.5	13	23	2.0:1	120
JCA910-3000	9.0-9.5	25	1.3	0.5	13	23	1.5:1	150
JCA1112-3000	11.7-12.2	27	1.4	0.5	13	23	1.5:1	150
JCA1415-3001	14.4-15.4	35	1.6	1.0	14	24	2.0:1	200
JCA1819-3001	18.1-18.6	25	2.0	0.5	10	20	2.0:1	200
JCA2021-3001	20.2-21.2	25	2.5	0.5	10	20	2.0:1	200

Millimeter Wave Amplifiers

Model	Freq. Range GHz	Gain dB min	N/F dB max	Flatness +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ	VSWR In/Out max	DC Current mA
JCA2629-201	26.0-29.0	19	5.0	1.5	5	15	2.0:1	100
JCA2629-401	26.0-29.0	35	5.0	1.5	5	15	2.0:1	200
JCA2730-205	27.5-30.0	15	5.0	1.0	15	25	2.0:1	200
JCA2730-302	27.5-30.0	26	5.0	1.0	8	18	2.0:1	150
JCA2730-502	27.5-30.0	43	5.0	1.0	8	18	2.0:1	200
JCA3031-102	30.0-31.0	18	5.0	1.5	8	18	2.0:1	100
JCA3031-302	30.0-31.0	34	5.0	1.5	8	18	2.0:1	200
JCA3031-405	30.0-31.0	40	5.0	1.5	15	25	2.0:1	400
JCA2640-301	26.5-40.0	30	5.0	2.5	0	10	2.0:1	160

Product Options:

- Limiting amp
- Variable gain control
- TTL switching
- Temperature compensation
- Alternate gain, N.F., power, VSWR levels
- Input/output isolators
- Waveguide interface

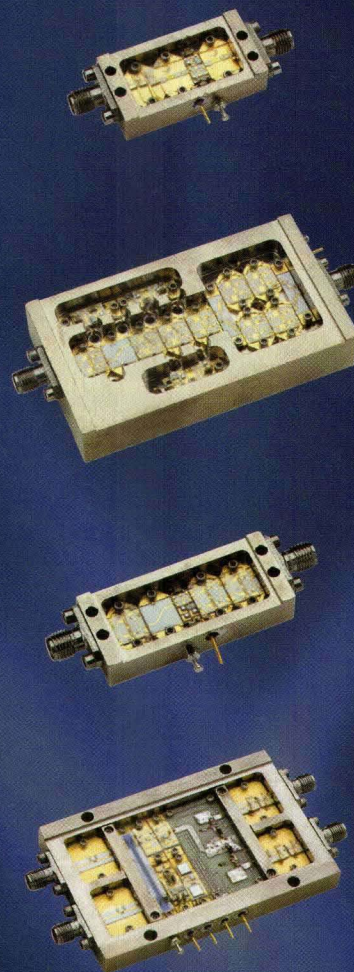
2584 Junction Avenue, San Jose, CA 95134-1902
 p: 408 ■ 919-5300 f: 408 ■ 919-1505
 www.jcatech.com ■ e-mail: jca@jcatech.com

Request for quote!
Call, fax, or e-mail.

Free catalog!
Call or download.

JCA
TECHNOLOGY

a  NEW FOCUS® company



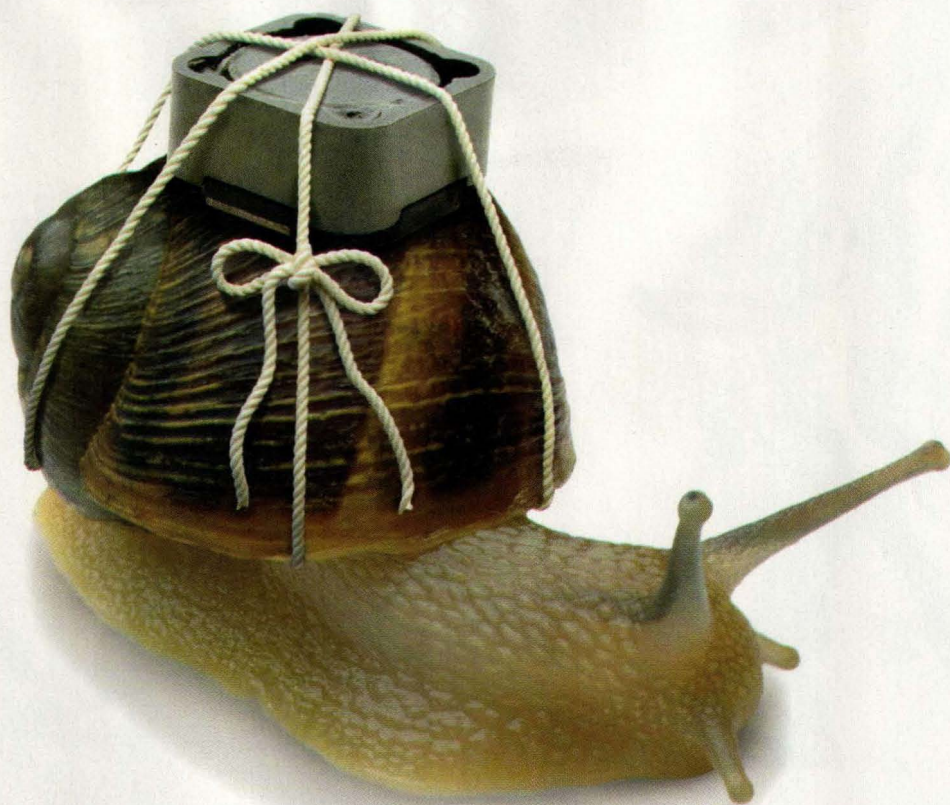


People want wireless services that go in new directions. So we make semiconductor technology that lets you go in new directions.

It may not look like semiconductor technology you've seen before, because it isn't like semiconductor technology you've seen before. It's a total silicon system solution approach that gives you a flexible, reusable, multimedia-capable, completely standards-compatible approach to mobile wireless. Our ARM-based solutions, for instance, let you deliver the voice, video, 3D graphic and text capability that people want, while giving you the highest level of integration available for wireless terminals and other handset devices. And all support Bluetooth, 802.11 and ZigBee. What's more, because people will always want new things from mobile wireless, we offer a broad portfolio of media processing ICs, and we're leading the way with next-generation standards, such as UMTS. It's living technology. And it's only from Philips. For complete technical information and applications overview, visit us at www.semiconductors.philips.com/wireless.

PHILIPS

Let's make things better.



How most inductor companies get samples to you

Coilcraft has the best samples program in the business. Always fast. Always free!

We know how crunched you are for time. So we make it as easy as possible to get free evaluation samples of our inductors, filters and transformers.

The fastest way is on our web site. Click the part numbers you want and they drop into a samples shopping cart. We ship almost everything the same day!

Not fast enough for you? Then order one

of our handy Designer's Kits. There are over 60 kits for our most popular products that put every value in the series at your fingertips. You can buy our kits on line, too.

The fast pace continues when you go to place production orders. Because we sell direct rather than through distributors, you have access to our complete line. It's all in stock, ready for same day shipment.

If your magnetics supplier works at a snail's pace, zip over

to Coilcraft. Visit us at **www.coilcraft.com**.

Part number Click for samples	Indu (nH)
0402CS-1N0X-B	1.0
0402CS-1N9X-B	1.9

Order samples on-line with a single click!

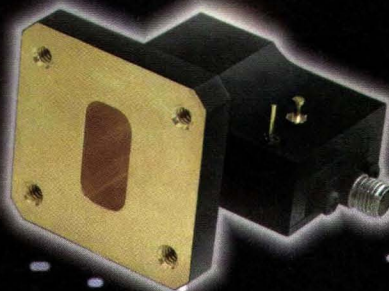
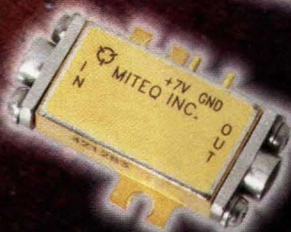
ORDER DIRECT
800-322-2645
OVERNIGHT DELIVERY! CALL BY 5 CST.

Coilcraft®

www.coilcraft.com 800/322-2645

SPACE QUALIFIED **COMPONENTS**

AMPLIFIERS • MIXERS • SYNTHESIZERS • SUPERCOMPONENTS



PRODUCT APPLICATIONS

- SATCOM LNAs
- Spaceborne Radar
- Transmitter Drivers
- Radiometric Sensors
- ELINT Receivers

OFFERING DESIGNS

- From 2 kHz to 60 GHz
- Optimized for Low Power Consumption
- Meeting MIL-PRF-38534 Class K or MIL-STD-883 Class 5
- Capable of Withstanding the Rigorous Demands of Long Mission Life



For further information, please contact David Krautheimer
at (631) 439-9413 or dkrautheimer@miteq.com



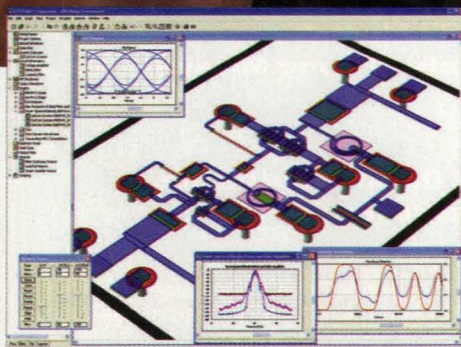
100 Davids Drive, Hauppauge, NY 11788
TEL: (631) 436-7400 • FAX: (631) 436-7430

www.miteq.com



© 2002 Applied Wave Research, Inc. All rights reserved. The Etch A Sketch® product name and the configuration of the Etch A Sketch® product are registered trademarks owned by The Ohio Art Company.

Still doing tomorrow's designs with yesterday's layout tools?



Are you toying around with outdated layout tools that make you anything but agile? Have you considered switching to Microwave Office™ 2002? It was designed from the ground up to support complex layout problems like LTCCs, MMICs and RFICs, not to mention dense PCBs—with advanced capabilities like design rule checking, 3D views, and the industry's only truly unified database. Which means you'll never have to deal with those problematic design synchronization steps or back annotations that can ruin your day. It also comes with manufacturing interfaces like Gerber, DXF and GDSII that actually work! Stop playing around, and start getting your designs out in no time flat. Make the switch to Microwave Office 2002. Download a 30-day evaluation from www.mwoffice.com or call us at 310-726-3000 for more information.



Electronic Articles

►►CONGRATULATIONS for a good article on "Simulators Model System Behavior" in the February issue (p. 33).

Is there a way that we can get this article in electronic form?

Andre C. Kobel

Vice President of Business Development
Elanix, Inc.

Editor's Note: Hello, Andre. Thanks for your kind words on February's system simulator story. It's a part of the software world that I think doesn't get enough exposure, so it was gratifying to get the word out on a pretty good current crop of system simulators. The article in question appears on our website in PDF form. There are PDF files of all the major articles in the issue. To find the article that you're looking for, go to our website at www.mwrf.com. Click on MWRf Archive. When the Archive listings page opens, click on

February 2003. The article is in the News section.

2003 Wireless Show

►►RAYTHEON RF COMPONENTS had a centrally located booth (#727) at the recent Wireless Systems Design Conference & Expo, which was held in San Jose, CA. This was an excellent location, and we attracted quite a few of the attendees. Although the show was noticeably smaller than last year in terms of attendees and exhibitors, we observed that this was an economic function and certainly not due to a lack of interest. Conversely, the conferences (although I did not personally attend) were reported to be excellent and booked. Also, of the leads that we scanned, 70 to 75 percent are qualified. In other terms, there was a higher concentration of 'true' leads acquired at this show

than we acquired at last year's show.

Raytheon RF Components' focus was devoted to the introduction of two new GaAs HBT power amplifiers specifically designed for the WLAN market: RMPA5251-251 (5-GHz InGaP HBT Linear MMIC power amplifier is ideal for use in 802.11a WLAN applications) and the RMPA2453-251 (2.4-to-2.5-GHz InGaP HBT MMIC power amplifier is ideal for use in 802.11b/g applications).

Catherine Austin

Raytheon RF Components

►►THE 2003 WIRELESS Systems Design Conference yielded an increased number of good sales leads compared to the 2002 show. This show provides a valuable forum for demonstrating new products and connecting with new customers.

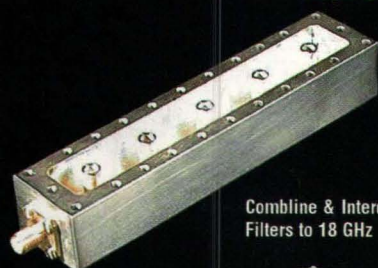
David Wick

Sales Manager

Honeywell RF/Microwave Solutions

1,239,580 Filters

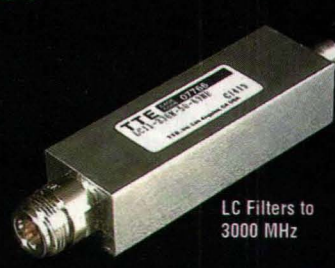
America's Filter Specialist since 1956



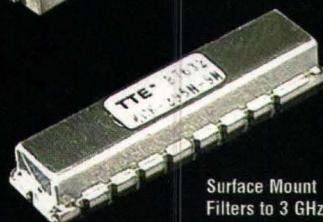
Comblane & Interdigital
Filters to 18 GHz



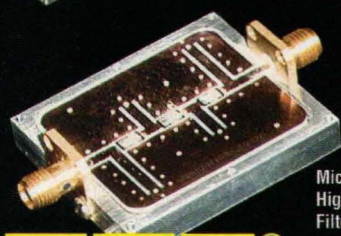
Diplexers and
Multiplexers to 18 GHz



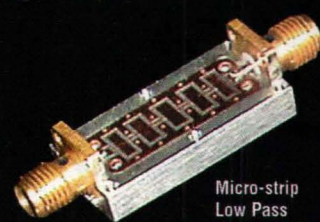
LC Filters to
3000 MHz



Surface Mount
Filters to 3 GHz



Micro-strip
High Pass
Filters to 18 GHz



Micro-strip
Low Pass
Filters to 18 GHz

Western Regional Sales Office:

11652 W. Olympic Blvd.
Los Angeles, CA 90064

Ph: 800.776.7614 310.478.8224

Fax: 800.473.2791 310.445.2791

E-mail: sls@tte.com

TTE[®]

www.tte.com



Eastern Regional Sales Office:

St. Pete Beach, FL

Toll Free: 866.363.0849

Ph: 727.363.0849

Fax: 727.363.7639

E-mail: sls@tte.com

THE WORLD'S LARGEST SELECTION

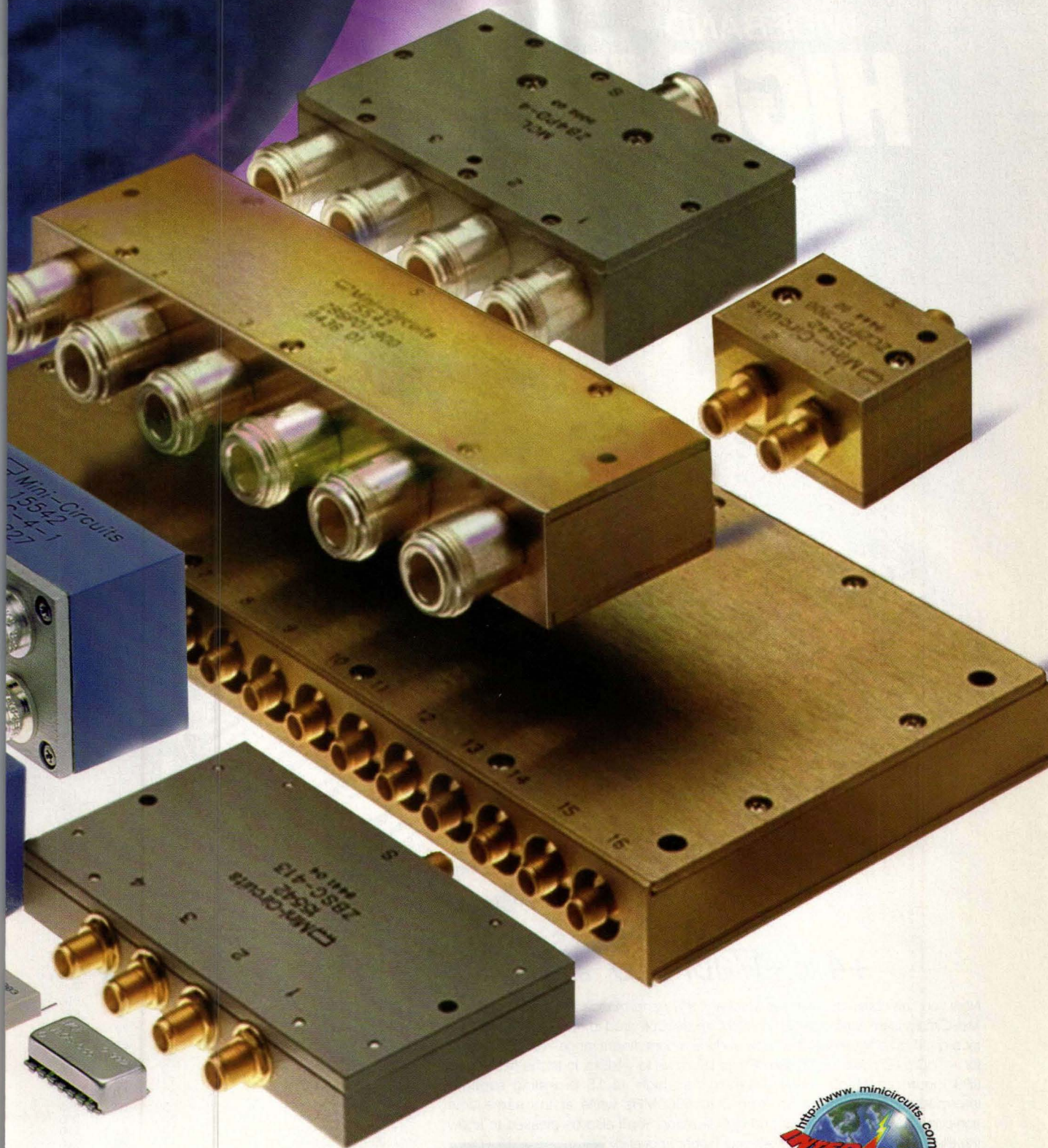
POWER SPLITTERS/ COMBINERS

IN STOCK



2kHz to 10GHz from 99¢

Choose from thousands of off-the-shelf models from Mini-Circuits, in stock and immediately available! From 2 and 3way to 48way; 0°, 90°, 180°; 50&75 ohms covering 2kHz to 10GHz and beyond...all characterized with data and performance curves in our catalog and "The YONI Search Engine" at our web site. Mini-Circuits will also supply your special needs and custom designs such as wider bandwidths, higher isolation, lower insertion loss and phase matched ports...all at catalog prices with rapid turnaround time. Case styles include surface mount, plug-in, flat pack, coaxial connectorized...and custom packages are no problem! Our super-miniature and ultra-low profile Blue Cell™ surface mount units provide excellent solutions in cellular, cable, and countless wireless applications. Plus all units come with a 1 year guarantee and skinny 4.5 sigma performance repeatability. Add unsurpassed applications support and value pricing, and the decision is easy. Contact Mini-Circuits today! **Mini-Circuits...we're redefining what VALUE is all about!**



see us on the web
<http://www.minicircuits.com>



Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001 ISO 14001 CERTIFIED

F 194 Rev D

See our 244 page RF/IF Designer's Guide in EEM (Electronic Engineers Master)

WIDEBAND HIGH IP3 MIXERS



+4 to +17dBm LO from **\$6⁹⁵**
(ea. Qty. 10)

Now you can obtain *spectacular wideband IP3 performance* at a value price with Mini-Circuits team of MBA, ADE, and SYM mixers. Optimized to deliver the highest IP3 for a given LO drive, these affordable surface mount mixers range from 32dBm IP3 for +17dBm LO power...to 15dBm IP3 for LO down to +4dBm. In terms of E Factor (IP3 Figure Of Merit), these mixers go as high as 1.5 providing superior intermodulation suppression from 5 to 5900MHz while at the same time achieving low conversion loss and high isolation. You'll also be pleased to know the Blue Cell™ MBA model covers your higher frequency designs with superb temperature stability, high repeatability, and ultra-thin 0.070" profile. Now, high IP3, higher performance, and value pricing have merged. The result is Mini-Circuits wideband high IP3 mixers...the *clear* choice!



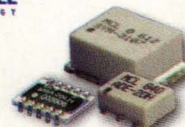
Mini-Circuits...we're redefining what VALUE is all about!

Typical Specifications:

Model	Freq. (MHz)	LO Level (dBm)	IP3 Midband (dBm)	E Factor*	Conv. Loss Midband (dB)	Price \$ea. Qty. 10
ADE-10MH	800-1000	+13	26	1.3	7.0	6.95
ADE-12H	500-1200	+17	28	1.1	6.7	8.95
•MBA-591L	4950-5900	+4	15	1.1	7.0	6.95
SYM-25DLHW	40-2500	+10	22	1.2	6.3	7.95
SYM-25DMHW	40-2500	+13	26	1.3	6.6	8.95
SYM-24DH	1400-2400	+17	29	1.2	7.0	9.95
SYM-25DHW	80-2500	+17	30	1.3	6.4	9.95
SYM-22H	1500-2200	+17	30	1.3	5.6	9.95
SYM-20DH	1700-2000	+17	32	1.5	6.7	9.95
SYM-18H	5-1800	+17	30	1.3	5.75	9.95
SYM-14H	100-1370	+17	30	1.3	6.5	9.95
SYM-10DH	800-1000	+17	31	1.4	7.6	9.95

*E Factor = [IP3 (dBm) - LO Power (dBm)] ÷ 10. See web site for E Factor application note.
ADE models protected by U.S. patent 6,133,525.

•MBA Blue Cell™ model protected by U.S. patents 5,534,830 5,640,332 5,640,699.



Actual Size

Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001 CERTIFIED

F 345 Rev A

The Military Is Important (Again)

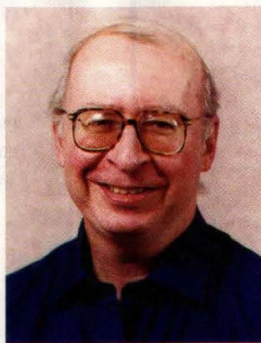
MILITARY ELECTRONICS IS ONCE AGAIN an important component of high-frequency business. News about the conflict in Iraq dominates broadcast airwaves and newsprint, as Coalition forces push for a speedy end to the war. This conflict is similar to the earlier Desert Storm, with our troops braving a hostile environment (sandstorms, heat) as well as the enemy. The technology is improved, however, from the earlier conflict, with enhanced Patriot missiles, for example, demonstrating far more effectiveness in neutralizing enemy Scud missiles now than in Desert Storm.

Unfortunately, war is not without loss, no matter how effective the technology. If war is inevitable (until human nature undergoes a fundamental change for the better), then investments in military technology can at least help to minimize loss of life and, hopefully, speed the resolution of a conflict. Of course, a pacifist would argue that more effective military technologies could also make the taking of life more efficient. But most military strategists and officers will admit that most military campaigns try to define and "neutralize" key targets, such as weapons storage facilities and communications installations, rather than targeting personnel.

The RF/microwave industry has long been synonymous with military electronics, given the industry's early roots in radar research and the MIT/Radiation Labs of World War II. Over the last decade, the industry has continued to improve the basic active and passive component technologies that contribute to the sensitivity of radar warning receivers (RWRs), the resolution of tracking radars, and the effectiveness of electronic-warfare (EW) systems. Even with the "distraction" of cellular communications and other alluring wireless markets during the decade of the 1990s, a solid core of microwave companies continued to support military electronics technologies in order to provide the US and her allies with strategic technological advantages.

For these companies, the Military Electronics Show (MES) was started almost three years ago, to provide a meeting place for engineers involved in military electronics of all forms, from amplifiers and computers to software and test equipment. Scheduled for September 16-17, 2003 in the Baltimore Convention Center (Baltimore, MD), the technical conference is co-sponsored this year by the IEEE's Aerospace and Electronics Systems Society. Some of the philosophy behind the event can be found at the MES website (www.mes2003.com); in essence, the show serves as a forum for design engineers to share the challenges they have faced and solutions they have found in working for military customers.

For the sake of our troops, we hope for a rapid conclusion to the Iraq war. For its part, the microwave industry continues to advance many of the key technologies that will give our troops an unbeatable edge.



The RF/microwave industry has long been synonymous with military electronics.

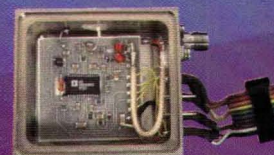
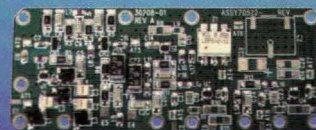
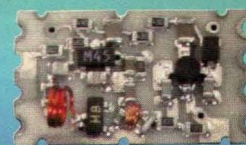
Jack Browne
Publisher/Editor

VALUE ADDED OPERATIONS FOR & MICROWAVE RF ASSEMBLIES

- CONTRACT MANUFACTURING
- BUILD TO PRINT/BUILD TO SKETCH
- SMALL TO MEDIUM QUANTITIES
- HIGH QUALITY WORKMANSHIP
- IPC-A-610/EIA J-STD001 CERTIFIED ASSEMBLERS AND INSPECTORS
- TEST SERVICES AVAILABLE
- RF & MICROWAVE CIRCUIT BOARD MANUFACTURER

MID-ATLANTIC PRODUCTS

HERE ARE THREE EXAMPLES OF THE NUMEROUS SOLUTIONS MID-ATLANTIC RF HAS PROVIDED OVER THE YEARS. WE MEET SPACE AND BUDGETARY REQUIREMENTS. CONTACT US TODAY FOR A DESIGN CONSULTATION!



 **MID-ATLANTIC
RF SYSTEMS, INC.**

PO BOX 745,
FOREST HILL, MD 21050
TEL: 410/893-2430
FAX: 410/638-5193
EMAIL: info@midatlanticrf.com
www.midatlanticrf.com

Model 9640 Dual HF Receiver

Frequency Range — 0.56 to 32 MHz

Instantaneous Bandwidth — 10 MHz

Noise Figure — 10 dB Maximum

Gain — 48 dB ± 2 dB

Synthesizer Control — RS-232C Interface

Synthesizer Tuning Speed — 100 μ s Maximum

Frequency Synchronous or Independent Operation

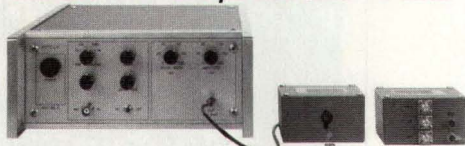


Interad Ltd.

18321 Parkway • Melfa, VA 23410
Phone: 757-787-7610 • Fax: 757-787-7740
www.interadlimited.com
e-mail: sales@interadlimited.com

Pulsed Laser Diode Driver Model AVO-9B-C

0 to 200 mA ~ 200 ps rise time ~ 1 MHz



Features socket-mounting of laser diode

- ★ Peak currents to 200 mA
- ★ PW from 5 to 100 ns
- ★ PRF to 1.0 MHz
- ★ 200 ps rise, fall time
- ★ Includes AVX-S1 output module for socket-mounting of laser diode
- ★ Can also be used as a 50 Ohm pulse generator
- ★ Models with IEEE-488.2 GPIB and RS-232 interfaces also available

The AVO-9B-C is a socket-mounted laser diode driver providing peak currents to 200 mA, and rise and fall times of less than 200 ps. This model includes an AVX-S1 output module, which houses the socket for the user's laser diode. The output module matches the laser diode to the pulse generator mainframe. A DC bias may be applied, and a diode current monitor is provided.

Avtech offers 7 models in this series providing peak currents to 1 Amp and pulse widths to 200 ns. Four models feature an IEEE-488.2 GPIB option. Forty other models provide 10, 50, and 500 Amp outputs!

For more detailed information on our fast laser diode drivers, pulse, impulse, delay and function generators, probes, amplifiers, and more, call or email us, or visit our web site for complete data sheets or to request our 113 page catalog.

Data sheets and pricing on the Web - www.avtechpulse.com

AVTECH



ELECTROSYSTEMS

NANOSECOND
WAVEFORM ELECTRONICS
SINCE 1975

BOX 265, OGDENSBURG
NY, 13669-0265
ph: 800-265-6681, 613-226-5772
fax: 800-561-1970, 613-226-2802
e-mail: info@avtechpulse.com
<http://www.avtechpulse.com>

UK: Lyons Instr. Japan: Meisho Corp.
Germany: FOIC Korea: MJL Crystek
France: K.M.P. Elec. Taiwan, China: Quatek

Microwaves & RF

A Penton Publication

HIGH-SPEED ELECTRONICS GROUP

Group Publisher Craig Roth, (201) 845-2448 • croth@penton.com
Publisher/Editor Jack Browne, (201) 845-2405 • jbrowne@penton.com
Technology Editor Nancy Konish, (201) 845-2428 • nkonish@penton.com
Managing Editor John Curley, (201) 845-2415 • jcurley@penton.com
Special Projects Editor Alan ("Pete") Conrad
Editorial Assistant Dawn Prior • dprior@penton.com
Contributing Editors Andrew Landrie, Allen Podell

MANUFACTURING GROUP

Director Of Manufacturing Ilene Weiner
Group Production Director Mike McCabe
Customer Service Representative
Dorothy Sowa, (201) 845-2453, fax: (201) 845-2494
Production Coordinator Judy Osborn, (201) 845-2445

ART DEPARTMENT

Art Director Armand Veneziano • aveneziano@penton.com
Group Design Manager Anthony Vitolo • tvitolo@penton.com

CIRCULATION CUSTOMER SERVICE (LIVE) (847) 647-6657
microwaves&rf@halldata.com

Reprints (800) 217-7874

EDITORIAL OFFICE

Penton Media, Inc.
45 Eisenhower Dr., Fifth floor, Paramus, NJ 07652
Phone: (201) 845-2446, fax: (201) 845-2493

PENTON TECHNOLOGY MEDIA

President David B. Nussbaum
VP, HR and Organizational Effectiveness Colleen Zelina



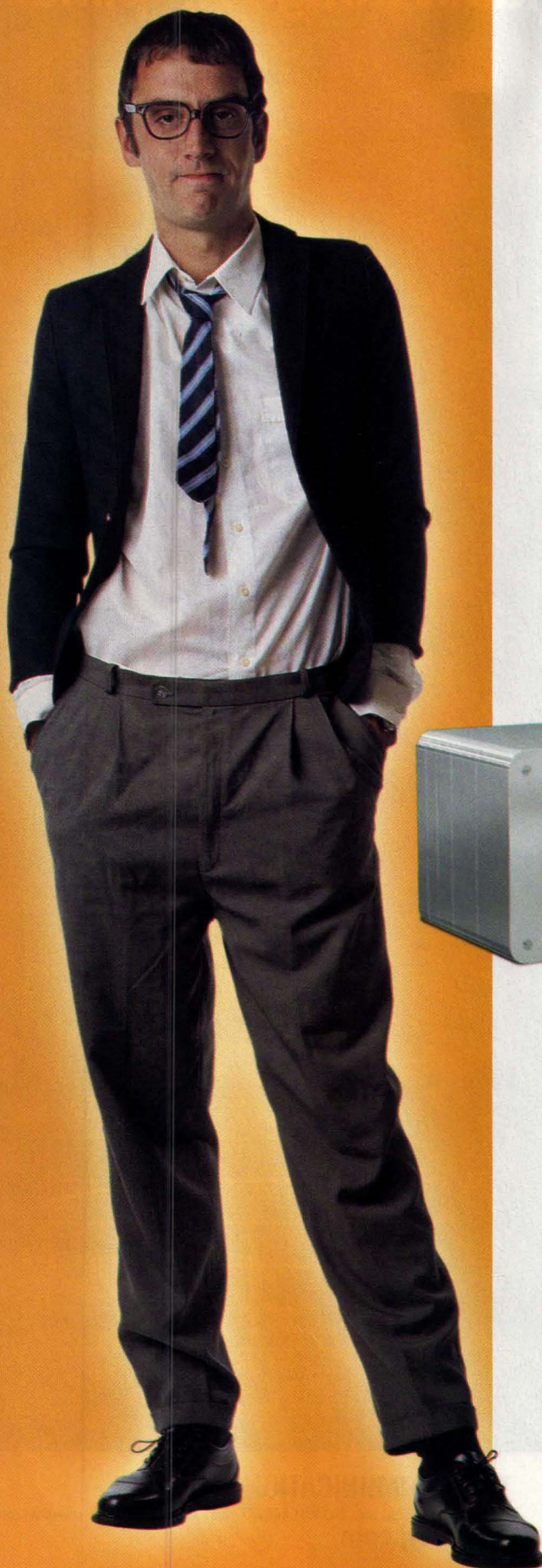
Chairman & Chief Executive Officer Thomas L. Kemp
President & Chief Operating Officer Daniel J. Ramella
Senior VP/Interim Chief Financial Officer Preston L. Vice
Chief Technology Officer R. Thomas Jensen
Exec. VP and President,
Penton Technology & Lifestyle Media David B. Nussbaum
Exec. VP & President, Penton Industry Media William C. Donohue
President, Penton Retail Media John J. Meehan
Senior VP, Human Resources Katherine P. Torgerson
VP & Controller Jocelyn A. Bradford
VP, Investor Relations Mary E. Abood

International editions are shipped via several entry points, including: Editeur Responsable (Belgique), Vuurgatstraat 92, 3090 Overijse, Belgique.
Microwaves & RF is sent free to individuals actively engaged in high-frequency electronics engineering. In addition, paid subscriptions are available by writing to: Microwaves & RF, P.O. Box 2095, Skokie, IL 60076.
Prices for non-qualified subscribers are:

	Single Copies		
	1 Yr.	Regular Issues	PDD Only
U.S.	\$ 85.00	\$10.00	\$100.00
Canada	\$110.00	\$12.00	\$125.00
Mexico	\$145.00	\$14.00	\$125.00
All other countries	\$145.00	\$16.00	\$125.00

Back issues of MicroWaves and Microwaves & RF are available on microfilm, microfiche, 16-mm, or 35-mm roll film. They can be ordered from Xerox University Microfilms, 300 North Zeeb Rd., Ann Arbor, MI 48106. For immediate information, call (313) 761-4700. Copying: Permission is granted to users registered with the Copyright Clearance Center, Inc. (CCC) to photocopy any article, with the exception of those for which separate copyright ownership is indicated on the first page of the article, provided that a base fee of \$1.25 per copy of the article plus 60 cents per page is paid directly to the CCC, 222 Rosewood Dr., Danvers, MA 01923. (Code 0745-2993/02 \$1.25 +.60) Copying done for other than personal or internal reference use without the expressed permission of Penton Media, Inc., is prohibited. Requests for special permission or bulk orders should be addressed in writing to the publisher.

Copyright © 2003 by Penton Media, Inc. All rights reserved. Printed in the U.S.



Sure, you'll buy your
wardrobe
out of a bin—but
when it comes to
synthesizers,
only top shelf will do.

WaveCor™



For the important things—like clean, pure, fast signals—only the best will do. That's why you should know about WaveCor Synthesizers from ITT Microwave Systems.

WaveCor Synthesizers use advanced proprietary digital techniques to produce signals from 50 MHz to 20 GHz, delivering the industry's best combination of ultra-fast switching, precise tuning, low phase noise and high spurious free dynamic range. This unparalleled performance is coupled with a flexible architecture, enabling solutions to be precisely tailored to your needs. The result? The best synthesizer value in the market today.

So dress up your next design with a WaveCor Synthesizer. They can make anybody look good—even this guy.

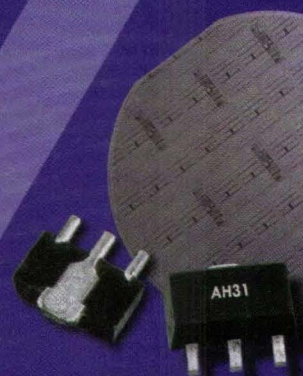
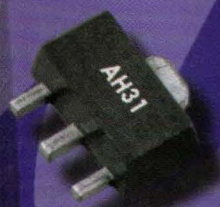


ITT Industries
Microwave Systems
Engineered for life

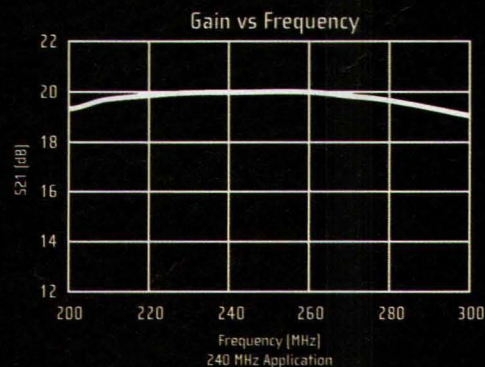
978-441-0200 • www.ittmicrowave.com

High Gain, High Dynamic Range Amplifier

- 20 dB Gain
- +40 dBm High OIP3
- 2.5 dB Noise Figure
- Frequency 50-600 MHz
- +5 V Supply



WJ Communications Inc. is a leading RF semiconductor company focusing on the design and manufacture of high-quality devices and multi-chip modules (MCMs) for telecommunications systems worldwide. WJ's highly reliable amplifier, mixer, RF IC and MCM products are used to transmit and receive signals that enable current and next generation wireless and wireline services. For more information visit www.wj.com or call (408) 577-6200.



THE COMMUNICATIONS EDGE™

WJ Communications Inc. 800-WJ1-4401 • fax: 408-577-6621 • sales@wj.com
www.wj.com

the front end

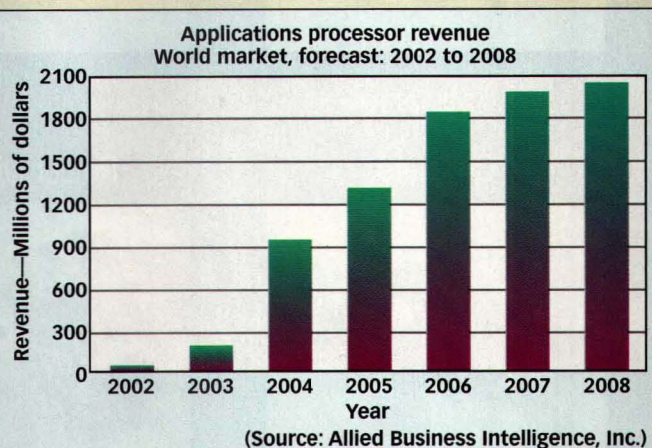
News items from the communications arena.

Applications Processors Represent A Big Growth Opportunity

OYSTER BAY, NY—There have been many advances in integrated-circuit (IC) technology that deliver the performance demanded by today's cellular handsets. According to an Allied Business Intelligence (ABI) report, "Handset Integrated Circuits: High Demands = Inevitable Integration," the market for handset ICs, currently at \$8.7 billion, is expected to grow to approximately \$12 billion by 2008 with a compound average annual growth (CAAG) of 5 percent. This available market projection includes consideration of the core components in the communications chain, including digital baseband, analog baseband, power management, RF transceiver, and applications processors.

However, of the core components, the applications processor represents the biggest growth opportunity for handset IC suppliers, with sales to manufacturers expected to reach over \$2 billion in 2008 (see figure) at a CAAG of 120 percent. One of the reasons for the explosive growth is the expected transition from 2.5G to 3G networks, coupled with ever-increasing demands for added functionality in handsets.

"The key to this market going forward is for IC suppliers to support handset vendors with a complete solution," said Tim Shelton, senior analyst at ABI and the report's author. "The applications processor is the next burgeoning opportunity for IC suppliers to capitalize on."



Two Firms Announce WLAN Licensing Partnership

MILPITAS, CA AND SAN JOSE, CA—Intersil Corp. and ParthusCeva, Inc. have announced a partnership to license Intersil's 802.11 WLAN IP to third parties.

"This partnership is a very significant development which will accelerate the deployment of WLAN technology across both business and consumer applications. Intersil is the acknowledged leader in 802.11 wireless solutions and ParthusCeva has a proven track record of delivering complex wireless technology under an IP licensing model," said Allen Nogee, senior analyst at In-Stat/MDR. "This unique combination can unlock the enormous potential of WLAN technology."

ParthusCeva will provide wireless IP expe-

rience, sales, marketing, and customer support in licensing Intersil's 802.11 Prism® Intellectual Property (Baseband Property and Medium Access Controller) to the electronics industry. PRISM solutions are the number-one deployed 802.11 WLAN technology in the industry. In addition, Intersil will supply PHY (radio front-end) products and reference designs—delivering a complete WLAN product solution to licensees. This up-integration strategy will enable new, wireless-capable products that will serve growing consumer demand for wireless connectivity wherever they live or work.

"The licensing of our WLAN IP is one of the next steps in addressing the needs of a growing market in which Wi-Fi is becoming pervasive and working its way into a diverse and exciting set of applications," said Larry Ciaccia, VP/GM of Intersil's Wireless Networking Product Group.



MIDWEST MICROWAVE

Attenuators



Fixed, Stepped, Continuously variable
Low VSWR, D.C. - 26.5 GHz, QPL

Terminations



Low to medium power, Open circuits
Short circuits, Low VSWR, D.C. - 26.5 GHz

D.C. Blocks



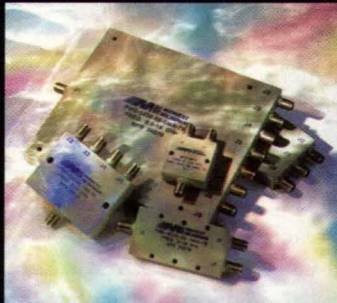
Inside/Outside, Inside Only
Rugged Construction

Couplers



Multi Couplers, Multi-Octave broadband
Hybrids, Octave bandwidth, D.C. - 18 GHz

Power Dividers



Broadband, Ultrabroadband, High Isolation
Low Phase & Amplitude Unbalance, D.C.-18 GHz

Equalizers



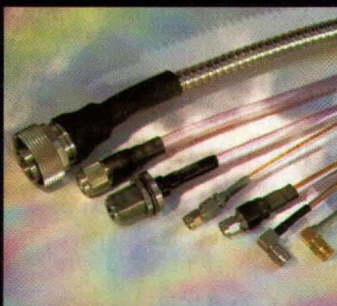
Broad or Narrow band, Fixed, Linear
Parabolic, Adjustable, D.C. - 18 GHz

Adapters



In - Series, Between Series, QPL
D.C. - 26.5 GHz

Cable Assemblies



Flexible, Phase Stable, Phase Matched
D.C. - 40 GHz

Delay Lines



Reformable, Phase Stable, Phase Matched
Delay Lines, D.C. - 40 GHz

For more information on any of these products and the rest of the Midwest Microwave range contact us:

United States and Canada

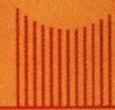
6564 South State Road, Saline Michigan 48176 Tel: 734 429 4773

Fax: 734 429 1415 E-mail: sales@midwest-microwave.com Web: www.midwest-microwave.com

International

Russell Way, Widford Industrial Estate, Chelmsford, Essex CM1 3AA United Kingdom Tel: 44 (0) 1245 359515

Fax: 44 (0) 1245 358938 E-mail: sales@midwest-microwave.ltd.uk Web: www.midwest-microwave.ltd.uk



Spectrum
Elektrotechnik GmbH

Telephone: +49-89-3548-04-0

Facsimile: +49-89-3548-0490

Email: specelek@CompuServe.com



Right Angled Connectors

Electrically: There is almost no difference, compared to our straight connectors. We are having the most advanced tools available to always design state-of-the-art connectors .

Mechanically: They are small! And if we say small, we mean small! They are only as big as the connector series requires! We do not sell connectors by the pound! We design connectors to the smallest possible configuration, as lightweight as possible!

The management philosophy at Spectrum Elektrotechnik GmbH is based upon the innovative concept of „Entrepreneurship“. A group of individuals act as a creative team within the corporate structure. Each team specializes in a particular product and completely understands and manages one of the product families. Spectrum Elektrotechnik GmbH has adopted the entrepreneurial system for one simple reason: Customer satisfaction. The effort of undivided attention is addressed to each single product, from design to manufacturing. No compromises are made, no details are overlooked. The team remains most alert to all customer requirements and is able to maintain complete communication with the customer. The result is complete understanding. Understanding begins already as the team studies the specifications. Goals are identified, a course is plotted. Questions are answered before they become problems; doubts are clarified before they are misunderstood. The team pilots each project through design, manufacturing and testing, until the ultimate objective is achieved: A quality product on time.

Please visit us @ www.spectrum-et.com

RFMD Announces GaN Process Technology Milestone

GREENSBORO, NC—RF Micro Devices, Inc. (RFMD), a provider of proprietary RF integrated circuits (RF ICs) for wireless-communications applications, has announced the achievement of a milestone toward the commercialization of gallium-nitride (GaN) RF power technology. RFMD has successfully grown, fabricated, and packaged GaN power transistors achieving 28-W performance with continuous-wave (CW) operation at 20 V. These GaN power transistors are fabricated from the current 0.9- μ m process and exhibit 10 dB of linear gain. The transistors were used to develop 20-W CW power amplifiers (PAs) for UMTS applications.

William Pratt, RFMD's chief technical officer, commented, "We're very enthusiastic about achieving these milestones in GaN power technology, which we believe demonstrate our technology leadership and our ongoing commitment to commercializing the most promising future semiconductor technologies. We believe GaN can conceivably lower the overall cost of wireless base stations and thereby prove to become a disruptive and revolutionary technology in the wireless-infrastructure space."

RFMD has also demonstrated 7-W wideband GaN PAs designed for DCS (1800 to 1880 MHz), PCS (1930 to 1990 MHz), and UMTS (2110 to 2170 MHz) wireless-infrastructure applications. The GaN PAs exhibit 11 dB of gain at 20-V operation, with gain slope of ± 0.2 dB over the entire range and better than ± 0.1 dB over the DCS and PCS bands. By exhibiting flat gain over a broad frequency range, the GaN PAs enable a single PA solution over DCS, PCS, and UMTS wireless-infrastructure bands. The matched PA exhibits an output return loss of -12 dB over the band with a typical input return loss of -11 dB at midband.

Dr. Jeff Shealy, vice president of the infrastructure amplifier product line at RFMD, said, "The advantages of gallium nitride are clearly demonstrated in the broadband power and gain performance of these matched amplifiers. This wideband performance is extremely difficult to achieve using semiconductor technologies that are commercially available today."

During the current quarter, RFMD delivered packaged engineering samples of the 7-W wideband GaN PAs to leading wireless-infrastructure OEMs.

Public WLAN Market Prospects Remain Strong In US & Europe

CAMBRIDGE, ENGLAND—Growth of the public wireless-local-area-networking (P-WLAN) market is set to continue in both the USA and Western Europe, according to a report by Analysys, a global telecommunications, IT, and media adviser. This growth is being driven by business travellers' appetite for cheap and fast remote access to the Internet.

The report, *Public WLAN Access in Western Europe and the USA: market analysis and forecasts*, anticipates that revenue will grow from \$33.4 million in 2002 (\$10.9 million in Western Europe and \$22.5 million in the US) to \$5.5 billion by 2007 (\$2.64 billion in Western Europe and just under \$2.8 billion in the US).

Hotspots, which are currently being installed in airports, hotels, conference facilities, cafés, restaurants, and rail stations, are estimated to grow from 4800 in 2002 (1400 in Western Europe and 3400 in the USA) to 57,000 by 2007 (30,000 in Western Europe and 27,000 in the US).

"Whilst take-up of public WLAN services has been slower than we anticipated, it still represents a significant opportunity for operators and other service providers," stated Maja Kecman, main author of the report. "In both Europe and the USA, telecoms operators have shown interest in the WLAN market as a complement to their existing networks, but have been cautious about investing in an uncertain market where there are still technological and regulatory issues to be resolved."

Market uncertainty is compounded by the fact that no single business model has yet emerged, commented the authors. The report outlines five main business models, the most common of which involves the hotspot-site owner and operator [or wireless Internet service provider (WISP)] acting as the main players in the P-WLAN value chain.

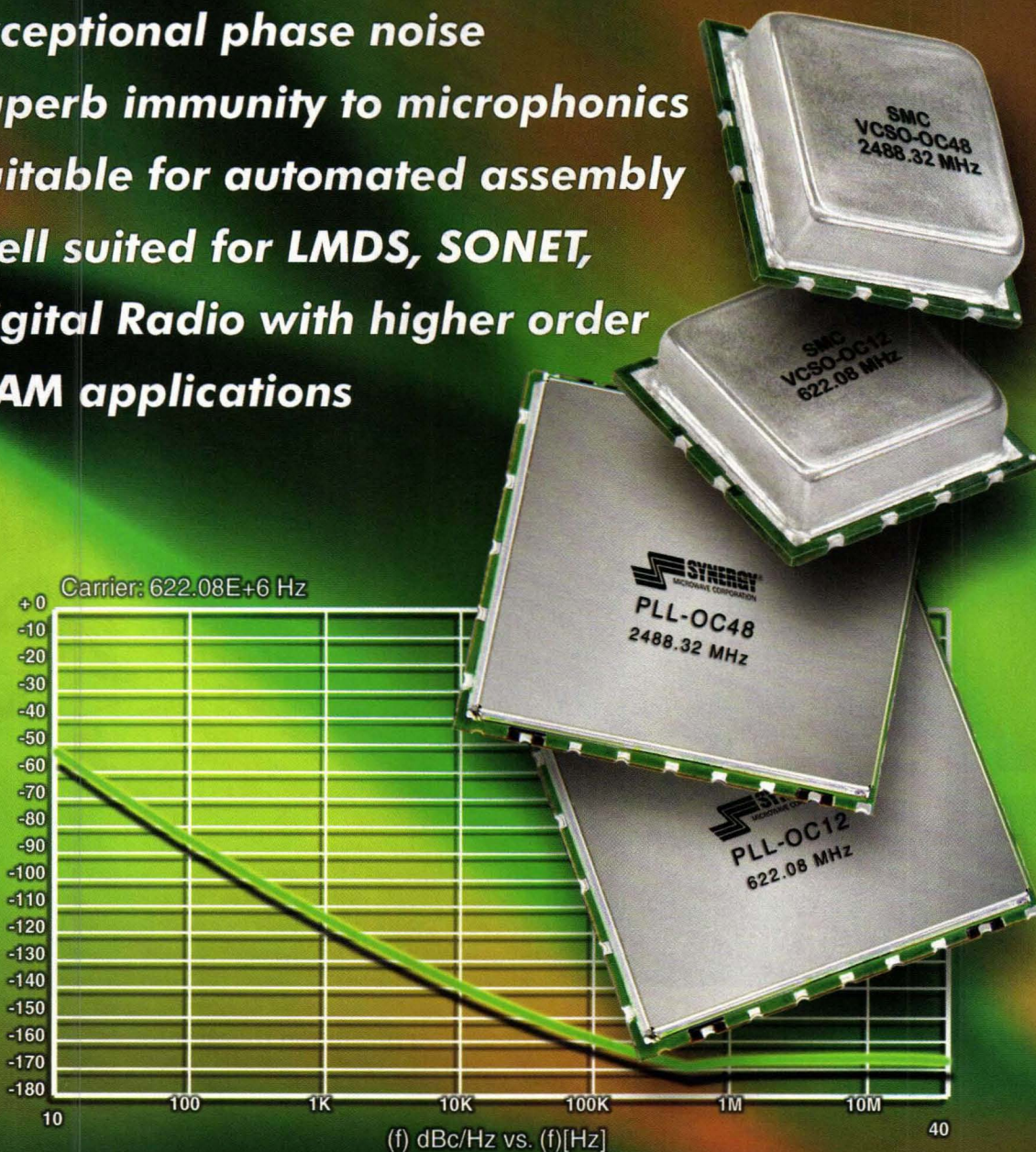
"We expect the dominant business models to evolve significantly in the next three or four years," said San Francisco-based report co-author, Monica Paolini. "By 2007, the US market will be characterized by a non-integrated value chain, with retail service providers not having exclusive control of the network infrastructure. In Europe, we expect fixed and mobile operators to prevail as they are able to leverage their existing customer base and backhaul agreements more effectively."

“Whilst take-up of public WLAN services has been slower than we anticipated, it still represents a significant opportunity for operators and other service providers.”

SAW

OSCILLATORS

- **Exceptional phase noise**
- **Superb immunity to microphonics**
- **Suitable for automated assembly**
- **Well suited for LMDS, SONET, Digital Radio with higher order QAM applications**



For additional information, contact Synergy's sales and application team.
201 McLean Boulevard, Paterson, NJ 07504
Phone: (973) 881-8800 Fax: (973) 881-8361 E-mail: sales@synergymwave.com
World Wide Web: www.synergymwave.com



See Us At MTT-S Show
Booth #2218



HFSS™

VERSION/NINE

The Power Of Next-Generation Design

HFSS v9 is sparking a revolution in microwave design—a revolution that brings electromagnetic precision into the design flow, cuts costs, improves manufacturability, and tackles more advanced designs than ever before.

With unprecedented accuracy and insight into electrical performance, HFSS v9's new architecture is reducing engineering time through parametric design entry, advancements in data management and design automation, and state-of-the-art algorithms. Developing on-time and on-the-mark products has never been easier.

HFSS v9—Put the power of next-generation design in your hands.

VERSION / NINE

ATION DESIGN 10101010101



www.hfss.com



Ansoft Begins Commercial Shipments Of Ansoft Designer

PITTSBURGH, PA—Ansoft Corp. has begun commercial shipments of Ansoft Designer™, a software product available for the design of high-frequency microwave and RF circuits and systems.

"The long history of dedication to accuracy makes the Ansoft simulation tools the best in class for RF and microwave design," said William Martin, principal staff engineer at Motorola, "which is why I rely on Ansoft for my RF integrated circuits and discrete circuit designs."

Ansoft Designer combines time-domain, frequency-domain, and system-level analysis tools to fully investigate the relationship between physical aspects and electrical performance before actually fabricating circuit, subsystem, or system components.

With the software's release, Ansoft introduces Solver on Demand™, a technology that gives every user, from novice to veteran, access to the most appropriate solver for a given design problem. With Ansoft Designer, all tools are always available for use, regardless of the task being performed at a specific time. The result is greatly reduced design time/complexity and a greater assurance that a circuit will operate as expected without further iterations.

Ansoft Designer can operate as a stand-alone tool or be incorporated into existing design flows, based on third-party EDA tools from vendors such as Cadence, Synopsys, Mentor Graphics, and Zuken.

Kudos

PALO ALTO, CA—Agilent Technologies, Inc. announced that BAE SYSTEMS has selected Agilent to provide a comprehensive package of RF and microwave EDA software, support, and on-site consulting. The Agilent Advanced Design System (ADS) electronic-design-automation (EDA) software will help streamline design processes and improve productivity of BAE SYSTEMS' RF and microwave module and monolithic-microwave-integrated-circuit (MMIC) development for communications, aerospace, and defense applications.

VISTA, CA—Palomar Technologies, a manufacturer of automated, high-precision assembly systems, announced that Hologic Corp.'s Direct

Radiography Division has selected Palomar's 3500-II automatic component assembly machine to automate production of hybrid microelectronics used in its DirectRay radiographic imaging technology.

Direct Radiography uses Palomar's 3500-II to automate assembly in two areas:

1. Fabricating microelectronic hybrids assemblies for digital medical-imaging applications.
2. Populating hybrid microelectronics sub-assemblies onto TFT flat panels for use in X-ray detectors for general radiography and mammography.

Both are components of Hologic's DirectRay technology, which uses a direct-conversion process to convert X-ray energy into a digital signal that produces a high-quality image with no intermediate steps.

SAN DIEGO, CA—StratEdge has received ISO 9001:2000 certification. Achieving ISO 9001:2000 certification indicates that StratEdge meets specific requirements for a quality-management system that demonstrates StratEdge's ability to consistently provide product that meets customer and applicable regulatory requirements and aims to enhance customer satisfaction. ISO 9001:2000 is the latest 9000 family standard defined by the International Organization for Standards and must be adopted by 2004.

ORLAND PARK, IL—Andrew Corp. recently completed a distributed communications project for Shanghai Mobile Communications Co. Ltd. (SMCC) that extended Global System for Mobile Communications (GSM) coverage throughout the Yan'an East Road Tunnel in the downtown area of Shanghai, China, including the section of road tunnel running beneath the Huangpu River. The extended GSM system enables Shanghai's mobile-phone users to maintain their phone connections within over 2 km of road tunnel.

CARSON CITY, NV—The Micromanipulator Co. has been awarded patents for its NANO-100™ SEM-based Probing System for probing structures less than 300 nm (below visible and NUV microscope resolutions). Patents #6,191,598B1 and #6,198,299B1 incorporate a method and system for probing with electrical test signals on an integrated-circuit (IC) specimen using a scanning electron microscope (SEM).

RANDOLPH, MA—Emerson & Cuming Microwave Products, Inc. has achieved ISO 9001:2000 certification. **MRF**

"The long history of dedication to accuracy makes the Ansoft simulation tools the best in class for RF and microwave design."



DC-6GHz ATTENUATORS ^{\$9.95} from ea. (qty. 1-9)

Mini-Circuits VAT and HAT fixed attenuators rank at the top of their class for high performance, big selection, and low cost! Choose from 14 different attenuation values; from 1 to 10dB in 1dB steps plus 12, 15, 20, and 30dB. All in stock, ready for immediate shipment, and *value priced* from only \$9.95 for BNC (HAT) and \$11.95 for SMA (VAT). Performance wise, these devices offer excellent attenuation flatness, low VSWR, and handle up to 500mW input power. Plus, rugged unibody construction makes them very easy to use in systems, testing, and product development applications. So get the best economy from your design with Mini-Circuits fixed attenuators.

Mini-Circuits...we're redefining what VALUE is all about!

Models		Attenuation* (dB)		VSWR (:1)	
SMA-M/F DC-6GHz	BNC-M/F DC-2GHz	Nominal	Flatness Midband Typ.	Midband Typ.	Midband Typ.
VAT-1	HAT-1	1 1	0.20 0.11	1.10 1.2	1.20 1.2
VAT-2	HAT-2	2 2	0.20 0.10	1.20 1.2	1.20 1.2
VAT-3	HAT-3	3 3	0.15 0.12	1.15 1.1	1.15 1.1
VAT-4	HAT-4	4 4	0.15 0.08	1.15 1.1	1.15 1.1
VAT-5	HAT-5	5 5	0.10 0.06	1.15 1.1	1.15 1.1
VAT-6	HAT-6	6 6	0.10 0.02	1.15 1.1	1.15 1.1
VAT-7	HAT-7	7 7	0.10 0.05	1.15 1.1	1.15 1.1
VAT-8	HAT-8	8 8	0.10 0.04	1.20 1.1	1.20 1.1
VAT-9	HAT-9	9 9	0.10 0.02	1.15 1.1	1.15 1.1
VAT-10	HAT-10	10 10	0.20 0.03	1.20 1.1	1.20 1.1
VAT-12	HAT-12	12 12	0.10 0.05	1.20 1.1	1.20 1.1
VAT-15	HAT-15	15 15	0.30 0.05	1.40 1.1	1.40 1.1
VAT-20	HAT-20	20 20	0.75 0.18	1.20 1.1	1.20 1.1
VAT-30	HAT-30	30 30	0.30 0.38	1.15 1.1	1.15 1.1

Power: 0.5W at 70°C ambient.

* Attenuation varies by ± 0.3 dB max. (VAT), ± 0.2 dB max. (HAT) over temperature.

•VAT MODELS \$11.95 ea. (qty. 1-9) •HAT MODELS \$9.95 ea. (qty. 1-9)

ALL MODELS IN STOCK

DESIGNER'S KITS AVAILABLE

K1-VAT: 1 of Ea. VAT-3, -6, -10, -20, -30 (5 total) \$49.95

K2-VAT: 1 of Ea. VAT-1, -2, -3, -4, -5, -6, -7, -8, -9, -10 (10 total) \$99.95

K3-VAT: 2 of Ea. VAT-3, -6, -10 (6 total) \$59.95

K1-HAT: 1 of Ea. HAT-3, -6, -10, -20, -30 (5 total) \$48.95

K2-HAT: 1 of Ea. HAT-1, -2, -3, -4, -5, -6, -7, -8, -9, -10 (10 total) \$97.95

K3-HAT: 2 of Ea. HAT-3, -6, -10 (6 total) \$58.95

Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001 CERTIFIED

F 363 Rev Orig

 WORLD'S WIDEST SELECTION

VCOs

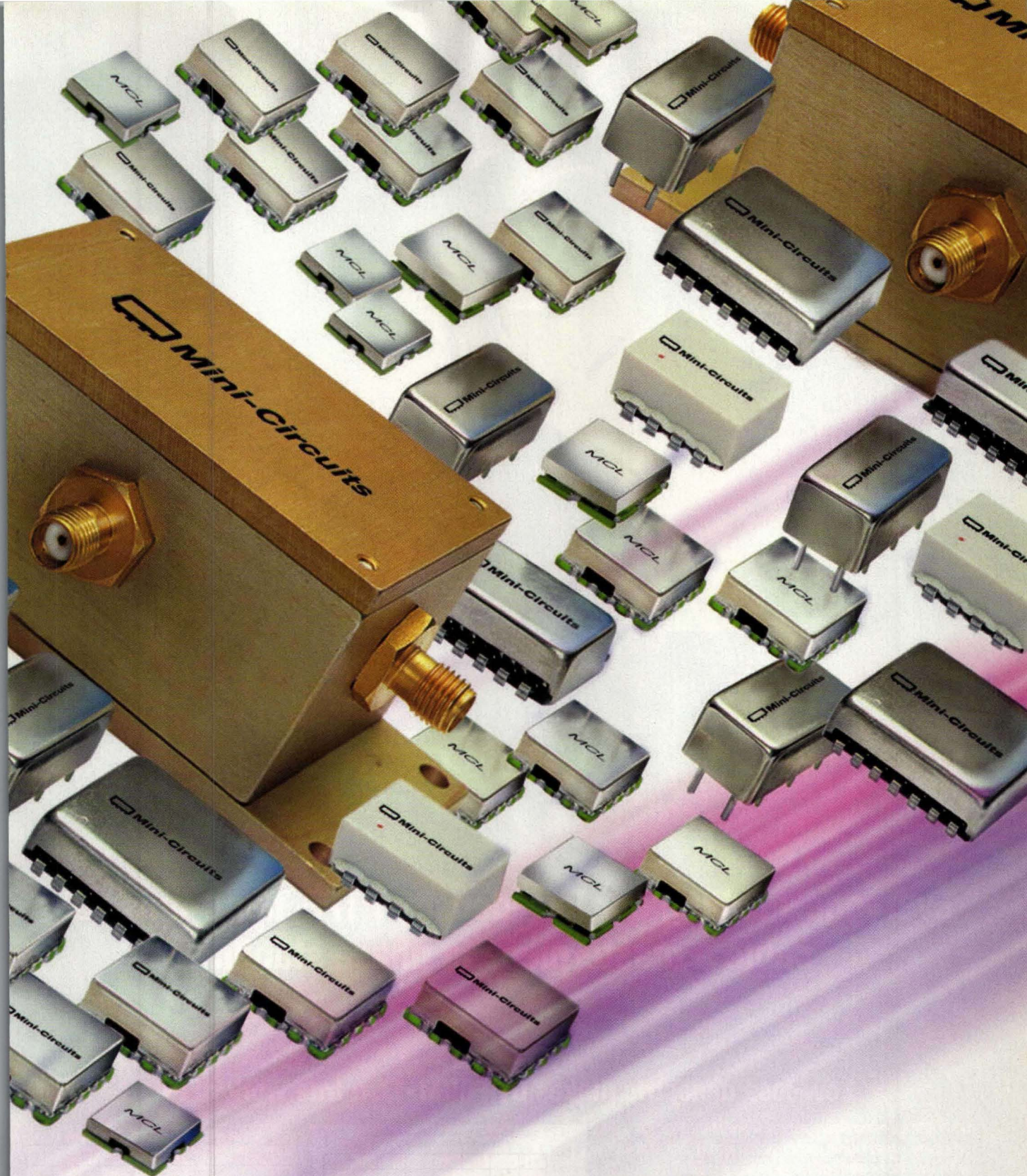
12.5 to 4000MHz **\$11⁹⁵**
from ea. (qty. 5)

Want a miniature surface mount, shielded plug-in, or rugged coaxial voltage controlled oscillator with the right stuff for your project? Contact Mini-Circuits! From custom designs to standard catalog models **always in stock**, we'll supply extra robust, 100% tested VCO solutions you need at a price you can afford. Choose from narrow to broad to octave band widths. Select linear tuning, low phase noise, and 5V models optimized for PLLs and synthesizers. And pick from an innovative array of miniature SM packages as small as 0.370" square for a variety of designs and applications. You can quickly find the model you need using "The YONI Search Engine" at the Mini-Circuits web site. Just enter your specs...click...and immediately start evaluating suggested VCO solutions using the *actual measured performance data* displayed. But perhaps you need a custom design. Not a problem! Contact us for our lightning fast response, low prices, and quick turnaround. Give the competition *real competition*...specify Mini-Circuits VCOs!

New VCO Handbook...FREE!

Mini-Circuits...we're redefining what VALUE is all about!





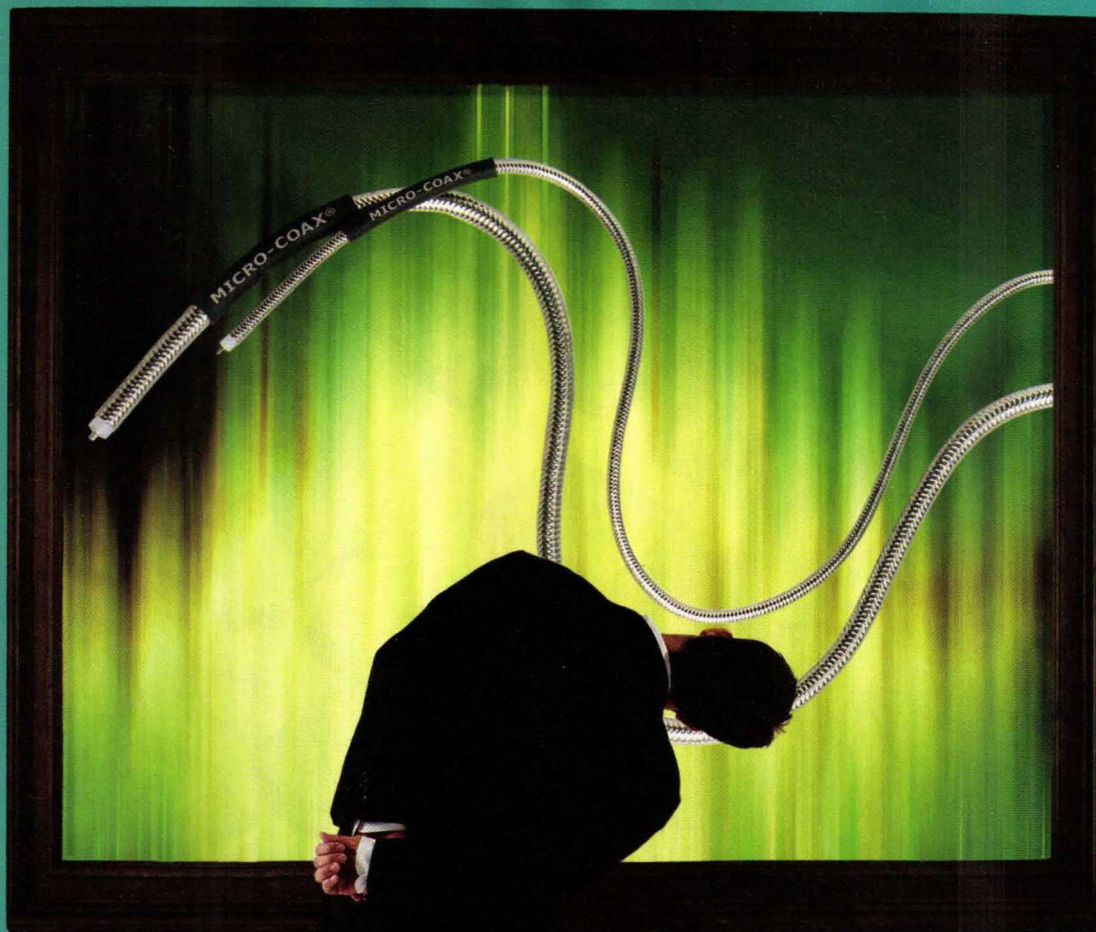
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001 ISO 14001 CERTIFIED

341 Rev. B



Everyone's calling our low-density PTFE, hand-formable cable a masterpiece in phase stability.

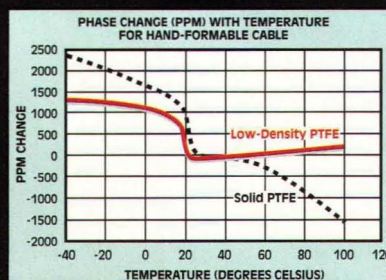
Low-loss dielectric makes UTiFORM[®]-LL a true work of art.

UTIFORM-LL microwave cables from MICRO-COAX combine exceptional dimensional and phase stability, with low insertion loss and ease of flexibility. Here are a few more reasons for taking a closer look:

- 40% improved phase stability over temperature
- Low-loss versions of UTIFORM exhibit up to 10% lower insertion loss than solid dielectric versions
- Rock-solid dimensional stability over temperature
- No thermal preconditioning of cable required
- 77% velocity of propagation (VP)
- No bend tooling required—makes routing a snap

UTIFORM-LL. Flexible performance you can count on.

For a **FREE** sample, call 1-800-223-2629 or visit www.micro-coax.com



	UT-85C-Form-LL	UT-141C-Form-LL
Diameter	0.085	0.141
VP	77%	77%
Dielectric	LD PTFE	LD PTFE
Typical Insertion Loss dB/100ft		
IL 0.5 GHz	13.7	7.2
IL 1.0 GHz	19.6	10.4
IL 2.0 GHz	28.1	15.2
IL 5.0 GHz	45.6	25.3
IL 10.0 GHz	66.4	37.9

MICRO-COAX[®]
Leading the way in transmission line solutions.

Linearizer Hikes PA Efficiency

This simple analog circuit requires only a handful of components to improve the linearity and/or efficiency of base-station and handset power amplifiers.

analog approaches may reap huge benefits for digital communications systems. That is the intention of the engineers at Cigma Technologies (Allendale, NJ), who have developed a unique analog predistortion-linearizer (PDL) circuit that promises to make wireless power amplifiers (PAs) at least 50-percent more efficient and consequently much smaller than designs incorporating the best alternative lineariza-

tion schemes, including feedforward techniques. The solution has been found to be effective with all wireless formats tested, including IS-95 code-division multiple access (CDMA), wideband CDMA (WCDMA), Universal Mobile Telecommunications Services (UMTS), Global System for Mobile Communications (GSM), and Enhanced Data-rate for GSM Evolution (EDGE) formats.

the well-established brand name Protek).

The PDL employs proprietary patent-pending Multi-Element RF Predistortion (MERP) technology to achieve the gain and phase control needed to linearize broadband single-channel and multichannel PAs. According to Richard Lisco, Cigma's vice president of engineering, the company's engineers evaluated a variety of techniques for linearization: "We considered ways to make a better linearizer, without using conventional, inefficient feedforward linearization. For example, we looked at distortion feedback and envelope feedback, but all of these approaches are bandwidth limited."

After a period of extensive research, the Cigma engineering team had an analog predistorter working in the laboratory. "The circuit is very simple and amenable to integration, and can be realized with very low-cost components," Lisco notes. The MERP PDL technology can be applied to both base-station amplifiers as well as handsets and cellular telephones. In essence, the PDL circuit consists

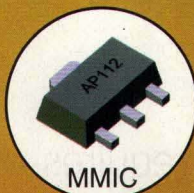
According to Cigma's president and chief operating officer (COO), Young Sohn, "New amplifiers built with this RF predistortion linearizer will be up to 50 percent more compact, will increase efficiency by at least 50 percent, and can be priced at 30 percent less than existing products." Sohn, having spent many fruitful years with software giant Oracle, headed an investment group that acquired Cigma this past year and established two operating divisions: a wireless amplifier group and a test and measurement instrument group (which will continue to operate under

JACK BROWNE
Publisher/Editor

LNA / Gain Block Converter Power Amp Sub-Modules LMDS & MMDS



LNA



MMIC

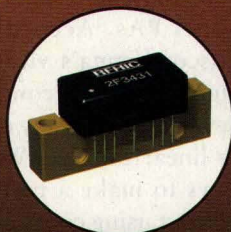


Converter



Sub-Modules

CATV Line Amp



RFHIC

Look for us at the
Cable-Tec Expo 2003
(Philadelphia, May 12-14)
Booth #2216

2003 MTT-Show
(Philadelphia, June 10-12)
Booth #2055

Tel : 82-31-420-5511
Fax : 82-31-420-5588

www.rfhic.com

rfsales@rfhic.com



Cigma Technologies' Young Sohn (right) and Rich Lisco hold an analog PDL circuit that can improve the linearity and efficiency of wireless/cellular base-station PAs.

of two voltage-controlled nonlinear modulators. The outputs of the modulators are summed to generate the desired gain and phase-transfer functions. Linearization is achieved by predistorting the amplitude and phase components of the input signal to the RF PA in a manner to correct for the amplifier gain and phase non-linearity.

Cigma confirms that the circuit has been tested with a number of in-house PA designs as well as PAs from Motorola (Schaumburg, IL) and handset RF IC PA modules, with as much as 15-dB reduction in distortion compared to tests run on the same amplifiers without the PDL circuit. Lisco points out that the PDL can also be used to improve amplifier efficiency, "or to transform a single-carrier amplifier into a multi-carrier amplifier." When used in a closed-loop approach, the PDL can deliver an additional 5 to 6 dB in margin. "For example," offers Lisco, "a manufacturer with a 20-W amplifier having a certain level of linearity may be able to achieve 30 W output power with that same level of linearity." The circuit can increase out-

put power for the same distortion performance, or maintain the same output power at a lower distortion level.

The analog linearizer (see figure) is designed for use with low-level input signals from -10 to 0 dBm. It is currently available in three basic versions for a variety of different operating bands. The basic model is the CT-PDL, with versions for 800 to 900 MHz, 1800 to 2100 MHz, and 2400 MHz. Optimally, the device is inserted prior to a PA's driver-amplifier input. The CT-PDLU is a version of the circuit (available in the same frequency bands) with 0-dB insertion loss to ease applications having limited available gain. Finally, the CT-PDLC is a closed-loop, adaptive version of the linearizer circuit complete with microcontroller-based automatic gain control, automatic pre-distorter tuning algorithms to maximize the signal to IMD ratio, and spectrum-monitoring capabilities for remote system provisioning and diagnosis. The complete module includes an RS-232 interface for alarm status and spectrum display. The microcontroller can set gain levels auto-

**SUPER FAST
VERY HIGH ISOLATION**

SWITCHES



\$195*
SPDT, DC-5GHz From ea. (10,000) **IN STOCK**

Very high isolation up to 90dB at 1GHz typical. Built-in TTL driver with blazing fast 10nsec switching speed. The ability to withstand severe operating temperatures down to -40°C to +85°C. That's what's great about Mini-Circuits wideband surface mount and coaxial SPDT switches. But that's not all! Reflective and absorptive models are available in three different package styles to suite your design requirements; M3SW's 3x3mm MCLP™ surface mount package with exposed metal bottom for excellent grounding and heat dissipation, SWM's SOIC-8 for easier assembly, and ZASW's tough built coaxial design with SMA-F connectors. No matter which model you choose, you'll get strong performance and rugged reliability at a price that crushes the competition. Check all the specs on our web site, then contact Mini-Circuits for our fast response!



SPECIFICATIONS (@ 1GHz)

Model	Freq. (GHz)	In-Out Isol. dB(typ)	Ins. Loss dB(typ)	1dB Comp. dBm(typ)	Price \$/ea. (Qty. 10)
• M3SW-2-50DR	DC-4.5	60	0.7	25	4.95 *
■ M3SWA-2-50DR	DC-4.5	65	0.7	25	4.95 *
• SWM-2-50DR	DC-4.5	55	0.7	25	5.30
■ SWMA-2-50DR	DC-4.5	65	0.7	25	5.30
• ZASW-2-50DR	DC-5	90	1.7	20	79.95
■ ZASWA-2-50DR	DC-5	90	1.7	20	79.95

Supply voltage +5V, -5V. TTL control.
Switching time 10nsec (typ).

- Reflective ■ Absorptive

ACTUAL SIZE



Mini-Circuits...we're redefining what VALUE is all about!

Detailed Performance Data & Specs Online at: www.minicircuits.com/model

Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001 ISO 14001 CERTIFIED

379 Rev F

See our 244 page RF/IF Designer's Guide in EEM (Electronic Engineers Master)

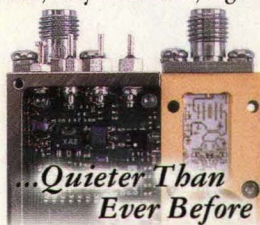


Quiet DROs for Clear Communication.

The desire for low noise Dielectric Resonator Oscillators to enhance clear communication, spectral purity, continues. Typical phase noise @ 100 KHz offset of -126 dBc/Hz for 10 GHz, -120 for 20 GHz and -114 for 40 GHz are being measured on our production DROs. Harmonics measured between -45 dBc and -50 dBc. Spurious are less than -85 dBc.

- No Phase Hits
- No Microphonics
- No Data Gaps
- No Interruptions
- Just Clear, Reliable Transmission

Check the Lucix Website for outstanding features of our DROs, such as low power consumption, very small size, high output power, ultra stability. Tell us your special needs.



At Lucix, we listen!



800 Avenida Acaso, Unit E • Camarillo, CA 93012 • Tel: 805.987.6645 • Fax: 805.987.6145
www.lucix.com

NEWS

matically while also simplifying the calibration process, without the need of a pilot tone.

In-house demonstrations and displays performed at the recent CTIA event (New Orleans, LA) have shown the PDLs to achieve better than 50-percent efficiency improvement when used with a multicarrier amplifier operating with four carriers (an operational bandwidth of about 80 MHz). The demonstrations also revealed a better than 10-dB improvement in distortion reduction. The beauty of the adaptive, closed-loop version of the circuit, notes Lisco, is its ability to maintain linearity even under

In-house demonstrations and displays performed at the recent CTIA event (New Orleans, LA) have shown the PDLs to achieve better than 50-percent efficiency improvement when used with a multicarrier amplifier operating with four carriers (an operational bandwidth of about 80 MHz).

extreme changes in environmental and operating conditions.

The PDL circuitry offers amplifier designers a chance to dramatically improve the performance of their existing single-carrier and multicarrier designs. The analog circuit provides open-loop (nonadaptive) or closed-loop (adaptive) corrections in PA performance that can translate into less power consumed in cellular base stations and more talk time per battery charge for cellular handsets. For a more detailed technical look at this innovative analog linearizer circuit, don't miss the follow-up PDL article in the May issue of *Microwaves & RF*. **MRF**

PRECISION PHOTO-FAB INC

Dedicated To Customer Satisfaction

Custom RF Shields

- Custom Design
- Custom Build
- Fast Delivery
- All Metals Available
- All Metals Available
- Low Tooling Costs
- Low Tooling Costs

Available Turnkey,
Soldering, Plated &
Formed Assemblies

4020 Jefferey Blvd.
Buffalo, New York
14219-2330
14219-2330

1 (800) 875-1093
fax: (716) 821-9399

Website: precisionphotofab.com

Solid State Tuner Technology For Noise Parameter And Load Pull Measurements

Manufactured By
Maury Microwave



On-Wafer Noise Parameter & S-Parameter
Measurement Setup (26-40 GHz)

**Certainty of first run success
by accurate measurement.**

- Ultra-fast Measurement
- Superior Repeatability
- Ideal for On-Wafer
- Unique Built-in Bias Circuitry
- Built-in LNA for Post Receiver
- In-Situ Calibration
- A Turnkey Approach
- Common C++ Software Platform
- ADS/Microwave Office Data Format
- Application Specific Modules
- Multi-Mode System Architecture
- Fixture and Pad De-Embedding

Direct
Connectivity
to Probe Tip
Minimizes
Loss!

*There has never been a better time
to call MAURY for a complete
measurement solution; mechanical,
solid state, or multi-mode.*

For more information about Maury RF Device Measurement Solutions
contact your local Maury sales representative, or call our Sales Department at:
(909) 987-4715



**MAURY MICROWAVE
CORPORATION**

www.maurymw.com

2900 Inland Empire blvd., Ontario, CA 91764 • USA • Tel: 909-987-4715 • Fax: 909-987-1112 • Email: maury@maurymw.com



Agilent Technologies

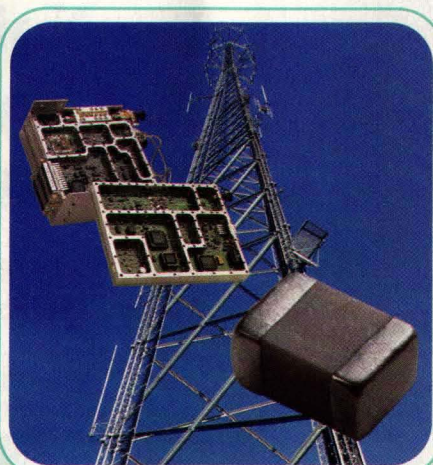
Channel Partner

For RF Device
Measurement Solutions

Capacitors Optimize Microwave Power Designs

DESIGNED SPECIFICALLY FOR RF and microwave power circuits and systems, the 600F series of multilayer-chip (MLC), high-quality-factor (high-Q) capacitors is ideal for use in cellular base stations, broadband wireless equipment, digital microwave radios, and low-phase-noise oscillators. The capacitors, which are available in values from 0.1 to 240 pF, offer low effective series resistance (ESR), high quality factor (Q), and 250-V working voltage in a standard 0805 EIA size. The capacitors, which are well suited for surface-mount-technology (SMT) applications, are formed with an environmental friendly tin over nickel barrier termination material for superior heat-conducting properties. The 600F series capacitors exhibit a temperature coefficient of capacitance of 0 ± 30 PPM/°C from -55 to $+125^\circ\text{C}$.

American Technical Ceramics Corp., One Norden Lane, Huntington Station, NY 11746-2142; (631) 622-4700, FAX: (631) 622-4748, e-mail: sales@atceramics.com, Internet: www.atceramics.com.



ATC'S 600F SERIES CAPACITORS



HITTITE'S HMC311LP3 MMIC GAIN-BLOCK AMPLIFIER

MMIC Amplifier Gains DC To 6 GHz

BROADBAND ENOUGH FOR a wide range of wireless applications, the model HMC311LP3 monolithic-microwave-integrated-circuit (MMIC) gain-block amplifier operates from DC to 6 GHz. It can be used as a cascable 50- Ω gain stage or as a local-oscillator (LO) buffer amplifier to provide as much as +17 dBm output power; the typical output power at 1-dB compression is +15.5 dBm over the full band. The MMIC amplifier, which is based on InGaP HBT technology, achieves an output third-order-intercept point of +32 dBm with typical full-band return loss of 15 dB and typical noise figure of 4.5 dB. The typical isolation is 18 dB.

Hittite Microwave Corp., 12 Elizabeth Dr., Chelmsford, MA 01842; (978) 250-3343, FAX: (978) 250-3373, Internet: www.hittite.com.



C-MAC MICROTECHNOLOGY'S TCXOS



IFR'S 2397 SPECTRUM ANALYZER

Tiny TCXOs Lock Next-Generation GPS

DEVELOPERS OF NEXT-GENERATION Global Positioning System (GPS) receivers and equipment can benefit from the stability offered by the new line of temperature-compensated crystal oscillators (TCXOs). The GPS-TCXO sources measure just 5×7 mm and exhibit very low microfrequency jumps of less than 5 PPB measured over 100-ms intervals. The TCXOs can also be specified with peak-to-peak frequency perturbations of only 0.4 PPM measured over small ambient-temperature changes (such as 2°C increments). Models are also available with frequency stability of ± 0.5 PPM for temperature ranges as wide as -40 to $+85^\circ\text{C}$. The oscillators, which exhibit negligible aging characteristics (no aging is specified), are available for standard GPS clock frequencies, including 10, 12.8, 16.3676, 19.44, 20.0, and 38.88 MHz.

C-MAC MicroTechnology, a Sollectron Co., 4222 Emperor Blvd., Suite 300, Durham, NC 27703-8466; (919) 474-3500, FAX: (919) 941-0530, e-mail: cmac.microtechnology@sollectron.com, Internet: www.cmac.com.

Budget Analyzer Scans 9 kHz To 3 GHz

WELL SUITED FOR wireless design and production testing, the 2397 spectrum analyzer offers unparalleled value for spectrum measurements from 9 kHz to 3 GHz. Priced at under \$7000, the spectrum analyzer offers sweep speeds of 50 ms to 1000 s, with resolution-bandwidth filters from 300 Hz to 3 MHz. The instrument covers frequency spans from 100 Hz/div to 300 MHz/div and allows operators to place as many as nine measurement markers for more detailed analysis. The 2397 weighs just over 20 lbs. and includes standard GPIB and RS-232 interfaces for connection to external computers.

IFR, An Aeroflex Co., 10200 West York St., Wichita, KS 67215-8999; (800) 835-2352, (316) 522-4981, e-mail: info@ifrsys.com, Internet: www.ifrsys.com.

High performance

Microstrip

Low cost

VCO

MFC, VCO & VFC Series

Microstrip resonator based offering superb phase noise performance and bandwidth from optimized to over an octave frequency generation.

Frequency range: 40 MHz to 6100 MHz

TFC Series

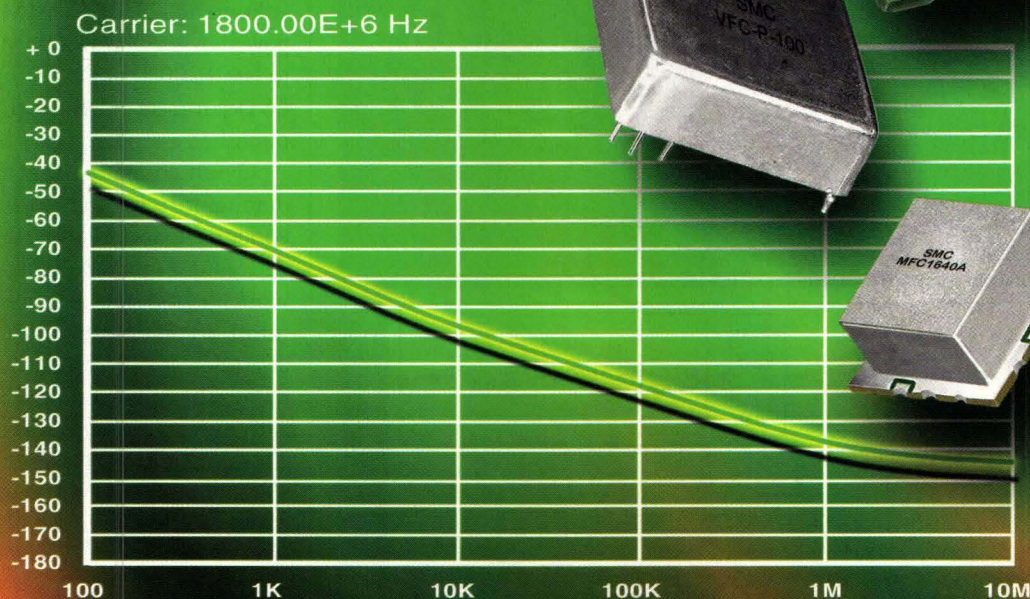
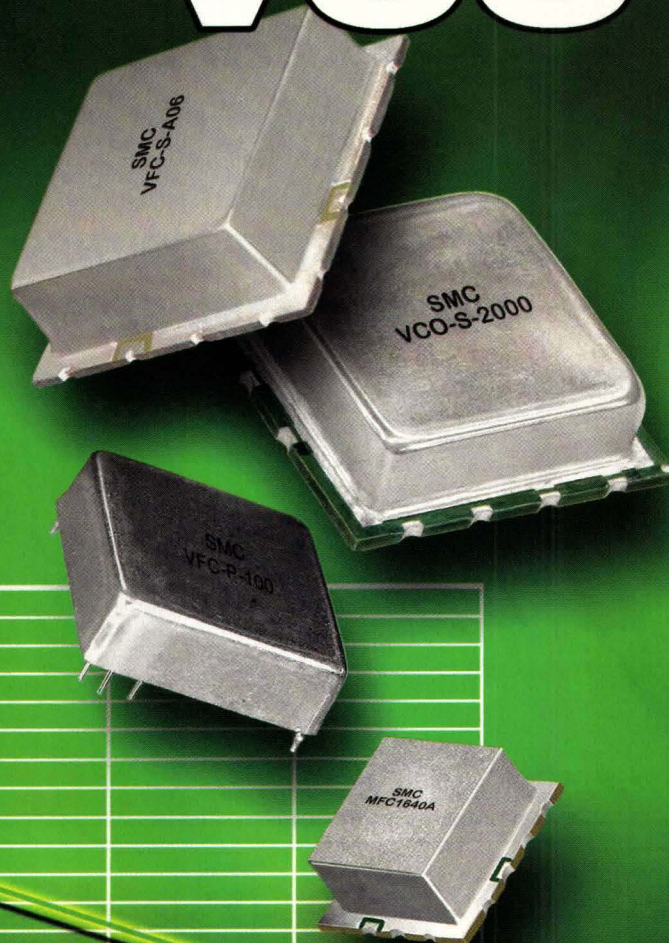
Microstrip resonator based and miniature style package for optimized bandwidth.

Frequency range: 100 MHz to 3000 MHz

Series 5

Dual isolated output with excellent phase noise and good stability

Frequency range: 50 MHz to 1000 MHz
(optimized bandwidths)



For additional information, contact Synergy's sales and application team.

201 McLean Boulevard, Paterson, NJ 07504

Phone: (973) 881-8800 Fax: (973) 881-8361 E-mail: sales@synergymwave.com

World Wide Web: www.synergymwave.com



See Us At MTT-S Show
Booth # 2218

Congressmen Rip Iraq GSM Plan

IN A LETTER TO US Defense Secretary Donald Rumsfeld, California Congressman Darell Issa and a growing

number of his colleagues criticized US Army plans to build a Global System for Mobile Communications (GSM)-based

wireless network in Iraq, according to Ovum, a European analyst company. Issa is in opposition to the resulting business that he presumes would go to French and German companies like Alcatel and Siemens. Issa decried that fact that "because of ill-considered planning, the US government will soon hand US taxpayer dollars over to French, German, and other European cell-phone equipment companies."

Code-division multiple access (CDMA) would be a better choice for the US Army to consider, Issa claimed, because it is "widely recognized as technically superior" and "provides all necessary access for law enforcement in post-conflict Iraq." In addition, Issa claimed that "hundreds of thousands of American jobs depend on the success of US-developed wireless technologies like CDMA." Issa represents the 49th District of California, north of San Diego. San Diego is home to QUALCOMM, a CDMA powerhouse. (QUALCOMM contributed to Issa's 2002 political campaign.) The US Department of Defense (DoD) has not published a reply to Issa's letter.

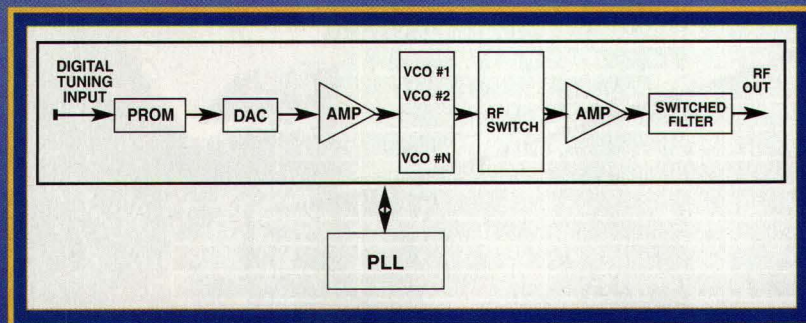
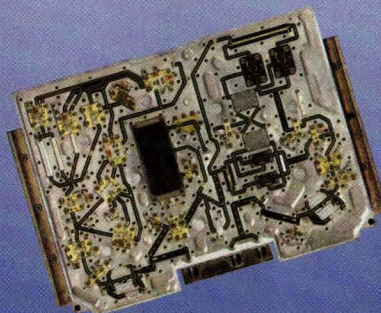
Ovum countered that GSM is the dominant technology in Iraq's neighboring countries of Turkey, Israel, Kuwait, and Saudi Arabia. Building a GSM network in Iraq is a better solution for future roaming capability and device interoperability, factors which are very important in integrating Iraq economically into the region, Ovum opined. More practically, Ovum claimed, US soldiers using CDMA devices in Iraq would still need to use GSM phones when they are back in regional bases outside the country.

Ovum claimed that there is irony in Issa's claims since the GSM and CDMA camps are partnering more than ever before. The wireless industry now realizes that subscribers care less about the technology than about the services that the technology enables and how much it costs. Solutions are global and collaboration is key, stated Ovum. **MRF**

TAKE A NEW LOOK AT
 **HERLEY**
 Industries, Inc.

FAST INDIRECT SYNTHESIZER FOR WIDEBAND RECEIVER

- 10 MHz to 18 GHz
- High speed 15 usec
- Dual mode, VME Package



Herley Farmingdale, 425 Smith St., Farmingdale, NY 11735
 TEL: 631-630-2000 • FAX: 631-630-2066
www.herley.com
 E-Mail: sales@generalmicrowave.com



Temex

Spirit of New technology
with a New Dimension in
the SAW industry with...
30 years of experience

The acquisition of Thales Microsonics^(*) by Temex offers you
a unique opportunity to source, in addition of SAW,
a full range of components for market segments such as:

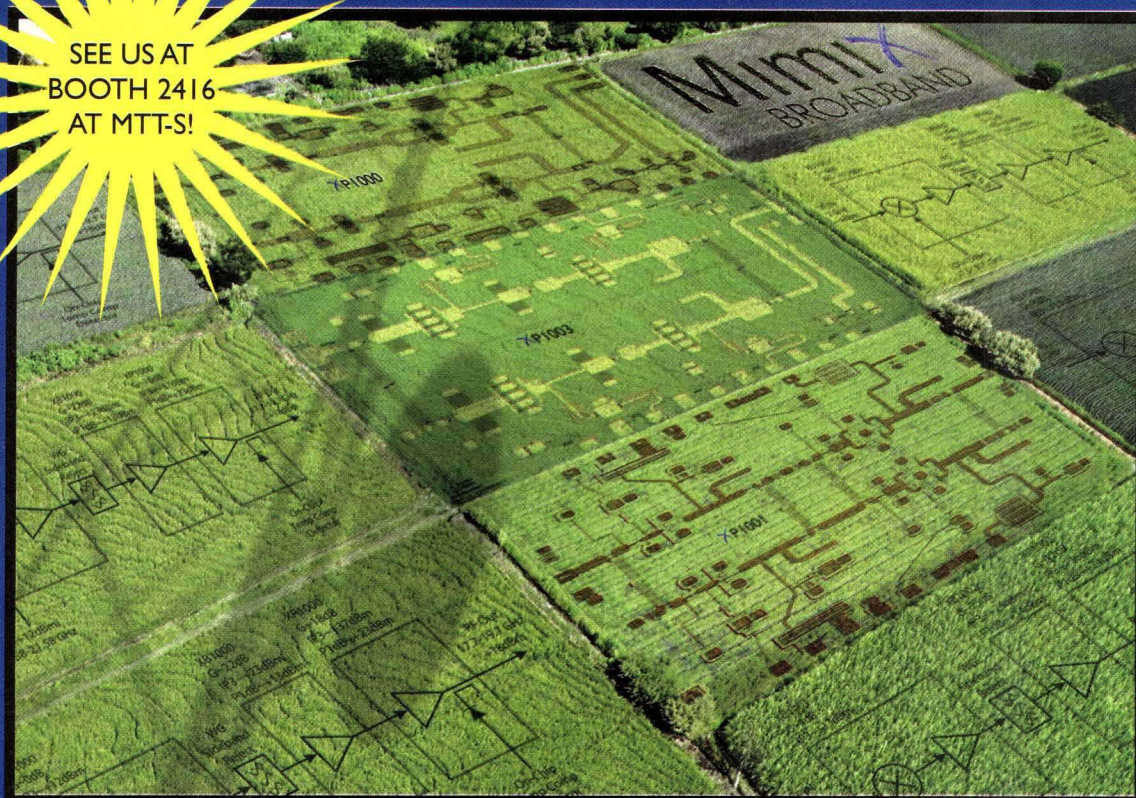
- Consumer
- Telecommunications
- Automotive
- Medical
- Military
- Space
- Instrumentation
- Telemetry

(*) Formerly Thomson Microsonics

To learn more, visit our website: www.temex.net

Visit us at: 3GSM™ World Congress 03 & Wireless Systems Design

SEE US AT
BOOTH 2416
AT MTT-S!



MIMIX BROADBAND IS OUTSTANDING IN THE HIGH POWER AMPLIFIER FIELD

Whether your application calls for a linear power amplifier with high OIP3 for superior operation in high index digital radio modulation schemes, or greater than one watt saturated power for high performance millimeter-wave constant envelope satellite or terrestrial radar applications...

Look to Mimix Broadband for a powerful solution.

Many of our power amplifiers also offer on-chip temperature compensated power detectors to eliminate the need for discrete detector circuits. And Mimix Broadband provides extensive testing on all amplifiers and even guarantees IP3, P1dB or Psat performance. We cover customer needs with excellent performance and diverse applications solutions.

Mimix Broadband's power amplifiers. Outstanding in our field.

CONTRACTS

Rockwell Collins—Announced that its Kaiser Electroprecision company has been awarded a contract for the design and development of the horizontal stabilizer trim actuator (HSTA) and sensor package for the new Falcon 7X business jet by Dassault Equipements, a division of Dassault Aviation.

The actuator for the Falcon 7X incorporates three independent means of drive using direct-current electric motors. The design is dual-load-path redundant throughout, and includes a secondary inverted thread nut and safety tie rod on the ballscrew to optimize safety and reliability. The system architecture addresses the stringent FAR/JAR requirements now associated with the certifiability of new HSTA's.

AT&T Government Solutions—Has been awarded a \$3.5 million contract from the Federal Trade Commission (FTC) to develop and implement a national registry containing phone numbers of consumers who do not wish to be contacted by telemarketers.

Beginning this summer, AT&T Government Solutions will make it possible for consumers to enter their phone numbers into the registry either by phone or via a website. Telemarketers will be required to download the database of 'do not call' numbers every quarter and discontinue telemarketing to these numbers. As many as 60 million consumers may use the registry when it is available later this year.

The initial \$3.5 million award runs through September 2003. The contract allows the FTC to extend the award for up to nine additional years.

Reynolds Industries—Announced that NASA has awarded them a Phase One SBIR contract for the development and qualification of improved miniature high-voltage connectors for deep-space use.

UTStarcom, Inc.—Has signed contracts worth approximately \$50 million with China Netcom Corp. for new and expansion deployments of its IP-based Personal Access System (PAS) in several northern cities in China.

Motorola—Has been commissioned by the Hong Kong Police to deliver its third-generation Command and Control Communications system (CC3). The value of this contract to Motorola is \$69 million and includes nine-year maintenance of the system.

FRESH STARTS

SoloMio Corp. and Telecom Media Networks (TMN)—Announced that they are partnering in Spain to deliver systems integration and strategic consulting expertise to SoloMio customers.

As part of the agreement, TMN will be establishing a new center of competence and excellence in Spain to meet future customer requirements and demand expected from the Span-

ish market, which is expected to grow exponentially. A first competence center is already in place in France. Leveraging a two-year relationship with TMN as a partner for its Real-time Call Services, SoloMio will use the agreement to extend TMN's systems and consulting expertise to ensure rapid integration and deployment of their Smart Call Services Platform into operators' network environment and services strategy.

MMD Components—Have purchased the rights to the entire product portfolio of Monitor Products. The addition of Monitor's lines of crystals, oscillators, and crystal filters to MMD's line of products expands the scope of their offering, especially in the area of frequency control.

The crystals, oscillators, VCXOs, TCXOs, and OCXOs are all available with the same specs that were available from Monitor.

Fujitsu Microelectronics America—Moved its corporate headquarters to 1250 East Arques Ave., Sunnyvale, CA 94085-5401 on March 17. The move brings FMA to Fujitsu's corporate campus, alongside Fujitsu Technology Solutions, Inc. and other Fujitsu companies.

Accent Optical Technologies—Announced the placement of a high-power DiVA system at Modelithics, Inc. This is the second DiVA placed at Modelithics. The first, a DiVA 225 capable of 25-V and 1A operation, was installed in April 2002 and is being used for developing non-linear models for low- and medium-power transistors and diodes, based on pulsed IV measurements made on packaged, chip, and on-wafer device samples.

Phihong—Moved their US headquarters to a new and expanded facility in Fremont, CA. The new 30,000-sq.-ft. building will house and increased R&D team, as well as additional sales and engineering support staff.

The contact information for the new location is: Phihong U.S.A., 47800 Fremont Blvd., Fremont, CA 94538; (510) 445-0100, FAX: (510) 445-1678, e-mail: usasales@phihongusa.com.

NetVendor and Teradyne—Announced that the two companies have completed the sale of Teradyne's Manufacturing Software Group (MSG) to NetVendor, Inc. The two groups, both located in the metro Atlanta, GA area, have merged to become Visiprise, Inc.

The new corporation will focus on developing, marketing, and selling software solutions for discrete manufacturers, including manufacturing-execution-systems (MES) software, quality-management software, and new product introduction software. The Alpharetta, GA-based facilities that had served Teradyne MSG have become the new corporate headquarters of Visiprise.

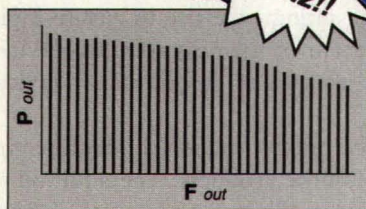
Intersil Corp. and ParthusCeva, Inc.—Announced a partnership to license Intersil's 802.11 WLAN IP to third parties.

Link Microtek—Has gained BS EN ISO 9001:2000 approval for its company-wide quality-management system.

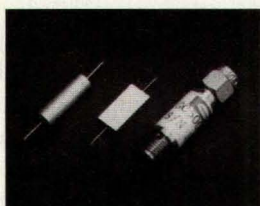
This latest approval extends the scope of the 1997 certificate to cover the design, manufacture, and sale of RF and microwave components, systems, and instrumentation. **MRF**

Harmonic (Comb) Generators for Output 0.1-50 GHz

Output
up to
50 GHz!!

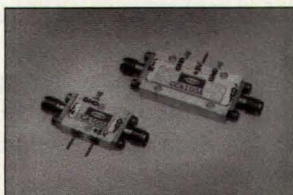


You can now select **any** input frequency from 10 MHz to 10 GHz and obtain output frequencies up to 50 GHz*



GC Series

- No Bias Required with Specified 1/2 Watt Drive
- Miniature Sizes
- Drop-In Modules or with Connectors



GCA Series with Integral Preamplifier

- 0 dBm or +10 dBm Input
- Drop-In Modules Available
- +5 V DC Power Supply or Integral Regulator for +12V or +15V Bias

*Please call factory for limits

Your Source for the Most Complete Line of Comb Generators

Other Herotek Products:

- Detectors • Limiters • Amplifiers •
- Switches • Multipliers •
- Subassemblies

Herotek

The microwave
products source

Herotek, Inc.

155 Baytech Drive
San Jose, CA 95134
Tel: (408) 941-8399
Fax: (408) 941-8388
Email: info@herotek.com
Website: www.herotek.com



people



KERYELL

Keryell Joins Link Microtek In Sales Position

MICK KERYELL has been appointed to the position of microwave product engineer for the North and Midlands of England by Link Microtek Ltd. Keryell was formerly employed in sales at several firms, including Tekelec and Frequency Techniques.

The ERNI Group of Companies—WENDY WUERTH-GRIGGS to vice president of sales and marketing for the Americas; formerly co-founded and worked as vice president of sales and marketing at Kycon, Inc.

The PXI Systems Alliance (PXISA)—BOB STASONIS to president; remains as marketing manager with Teradyne. Also, LOOFIE GUTTERMAN to director of marketing; continues as president at Geotest.

Agere Systems—JOHN W. GAMBLE JR. to executive vice president and CFO; formerly senior vice president and business controller.

EMS Technologies, Inc.—ROBERT P. CROZER to the board of directors; formerly chairman of the board at Keebler Foods Co. Also, DR. JOHN R. KREICK to the board of directors; formerly president of the Sanders division of Lockheed Martin Corp. and a Lockheed corporate vice president. In addition, DON T. SCARTZ to executive vice president; formerly CFO.

Kyocera Wireless Corp.—JIM KELLY to vice president of engineering to oversee the Development Engineering Group; formerly president and CEO at Skydesk, Inc.

MCE/Metelics, Inc.—GARY COONCE to marketing manager; formerly a sales representative with Jay Stone Associates.

Bisco Industries, Inc.—LAURIE GEBAROFF to Southern regional sales manager; formerly Southern California sales manager. Also, LISA COOK to Eastern regional sales manager; formerly area manager over part of the Midwest and Eastern areas. In addition, ROBERT RIST to Northern region sales manager; formerly Western regional sales manager.

International Manufacturing Services, Inc. (IMS)—DAVID J. LONDON to director of sales and marketing; formerly employed as a sales and marketing consultant, specific to the RF and microwave-component industry, for DJLA Consulting. **Sandbridge Technologies, Inc.**—TANUJ RAJA to the HY-SDR Research Committee; remains as vice president for business development.

Sabritec—PETER BOREHAM to European business development manager; formerly technical manager for Brand Rex Ltd. and engineering manager for Deutsch Ltd. EMC Business.

Lamina Ceramics—DAVID MCCONAGHY to vice president of sales; formerly vice president of sales at TransEDA.

Kathrein, Inc., Scala Division—OSCAR HARRIS to regional sales manager for the Southeastern region; formerly employed with Trilog.

Lytron—TOM EYTEL to the position of manager of customer service; formerly technical operations manager at Speedline Technologies.



EYTEL



OVERBAUGH

Calmont Wire & Cable, Inc.—PAUL OVERBAUGH to director of product/process improvement; formerly employed in the plastics-packaging industry in various engineering and production-management roles. **MRF**

EIGHT WAYS TO JUMP START YOUR DESIGN

WITH GENESYS V8 SYNTHESIS

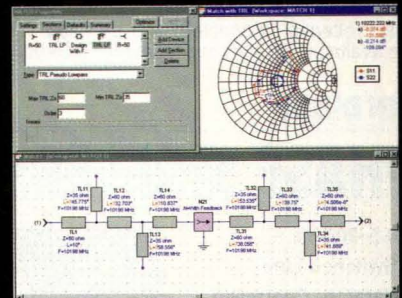
From Start To Finish. You're in the driver's seat with GENESYS V8's winning synthesis modules for amplifiers, oscillators, PLLs, filters and more. Need to design an x-band amplifier for example? Choose your transistor and start your engines.

The First Two Ways Make It Easy!

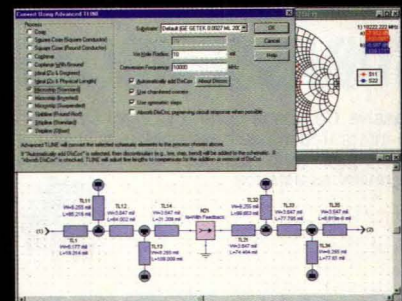
1. Use our MATCH module to synthesize your amplifier matching circuit. Simply enter your device models and matching network topologies and MATCH calculates the network parameters needed for an optimal match between source and load.

2. Then use **ADVANCED T/LINE** to automatically convert schematics between ideal, microstrip, stripline, coplanar and transmission line types. You'll jump start your design without even switching gears.

So Grab a Seat and Hold On! And get the extra power, speed and accuracy you need. With synthesis packages starting under \$3,000 US, you'll land the pole position every time.



MATCH synthesizes networks



T/LINE transforms into stripline, microstrip, coplanar and others

Phone: +1 678-291-0995

sales@eagleware.com



E
EAGLEWARE
 RF and Microwave Design Software

www.eagleware.com

Fax: +1 678-291-0971

PIN DIODE CONTROL DEVICES

PIN DIODE

ATTENUATORS

- 0.1–20GHz
- Broad & narrow band models
- Wide dynamic range
- Custom designs

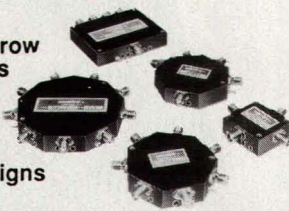


Attenuator types offered are: Current Controlled, Voltage Controlled, Linearized Voltage Controlled, Digitally Controlled and Digital Diode Attenuators.

PIN DIODE

SWITCHES

- Broad & narrow band models
- 0.1–20GHz
- Small size
- Custom designs

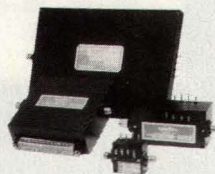


SPST thru SP8T and Transfer type models are offered and all switches are low loss with isolation up to 100dB. Reflective and non-reflective models are available along with TTL compatible logic inputs. Switching speeds are 1μsec.—30nsec. and SMA connectors are standard. Custom designs including special logic inputs, voltages, connectors and package styles are available. All switches meet MIL-E-5400

PIN DIODE

PHASE SHIFTERS

- 0.5–20GHz
- Switched Line
- Varactor Controlled
- Vector Modulators
- Bi-Phase Modulators
- QPSK Modulators
- Custom Designs



SUBASSEMBLIES

Passive Components and Control Devices can be integrated into subassemblies to fit your special requirements. Call for more information and technical assistance.



Custom Designs

CALL OR WRITE

waveline
SOLID STATE INC.

P.O. Box 718, West Caldwell, NJ 07006
(973) 226-9100 Fax: 973-226-1565
E-mail: wavelineinc.com

► SHORT COURSES

Converging Voice and Data Networks

April 28-29 (Anaheim, CA)
May 5-6 (Boston, MA)
May 12-13 (Atlanta, GA)
May 19-20 (Dallas, TX)
June 9-10 (Morristown, NJ)
Global Knowledge
9000 Regency Pkwy., Suite 500
Cary, NC 27511
(800) COURSES, FAX: (919) 461-8646
Internet: www.globalknowledge.com
Keyword: CONVERGENCE

Voice over IP

April 30-May 2 (Anaheim, CA)
May 7-9 (Boston, MA)
May 14-16 (Atlanta, GA)
May 21-23 (Dallas, TX)
June 11-13 (Morristown, NJ)

Global Knowledge
9000 Regency Pkwy., Suite 500
Cary, NC 27511
(800) COURSES, FAX: (919) 461-8646
Internet: www.globalknowledge.com
Keyword: VOIP

Indoor Networks: Principles & Practice of In-Building Wireless Engineering

May 7-8 (Washington, DC)
June 23-24 (Boston, MA)
August 7-8 (Miami, FL)
September 11-12 (San Francisco, CA)
For further information contact:
Dr. Eric Reifsnider
(540) 818-2281
e-mail: training@wirelessvalley.com
Internet: www.wirelessvalley.com/Services/Training.asp

R.A. Wood Short Courses

Wireless Engineering
May 12-16 (Cincinnati, OH)
Introductory RF and Microwaves
May 1-2 (Cincinnati, OH)
RF and Microwave Receiver Design
May 5-7 (Cincinnati, OH)
RF Power Amps, Classes A-S: How the Circuits Operate, How to Design Them, & When to Use Each

April 29-30 (Cape May, NJ)
May 8-9 (Cincinnati, OH)
R.A. Wood Associates
1001 Broad St., Suite 450
Utica, NY 13501
(315) 735-4217, FAX: (315) 735-4328
e-mail: rawood@rawood.com
Internet: www.rawood.com

Antennas: Principles, Design, and Measurements

April 29-May 2 (Dulles, VA)
Northeast Consortium for Engineering Education (NCEE)
Attention: Leanne Traver
68 Port Royal Square
Port Royal, VA 22535-0068
(804) 742-5611, FAX: (804) 742-5030
e-mail: ed-pub@crosslink.net

Internet: www.antennacourse.com

Microwave Antenna Measurements Short Course: Far-Field, Near-Field, Compact Ranges, and Anechoic Chambers

June 9-13 (Northridge, CA)
California State University, Northridge
Contact: Michelle Manchester
(818) 677-2146, FAX: (818) 677-5982
e-mail: michelle.manchester@csun.edu
Internet: www.ecs.csun.edu/~crs/mam/
College of Engineering and Computer Science

California State University, Northridge
Northridge, CA 91330-8295

Oxford Design Week

June 29-July 4 (Oxford, England)
St. Anne's College
Internet: www.rttonline.com

► MEETINGS

In-Building Wireless 2003

May 5-7 (Arlington, VA)
Sheraton National
IIRUSA's Sixth Annual Wireless Networking Summit
To exhibit, sponsor, or attend, call (800) 670-8200

e-mail: info@iir-inbuilding.com
Internet: www.iirusa.com/inbuildingwireless/

MOBILE AMERICAS 2003

May 19-21 (Miami, FL)
Trump International Sonesta Beach Resort
Internet: www.iirusa.com/MobileAmericas

► CALL FOR PAPERS

SDR '03

November 17-20 (Orlando, FL)
Deadline for technical-paper abstracts is May 1

For more information on technical-paper submissions, visit:

www.sdrforum.org/sdr03/call_papers.html

For more information on the event, to attend, or become a sponsor, contact Al Marguiles, chief operating officer, SDR Forum, at:

(315) 736-2433

e-mail: asm@sdrforum.org

2003 IEEE GaAs IC Symposium

November 9-12 (San Diego, CA)
Deadline for the electronic receipt of Abstracts is May 5

E-mail a one-page Abstract with up to two pages of supporting material to:

2003abstracts@sirenza.com

Submissions must be in .doc or .pdf format only

Further questions on Abstract submission can be addressed to:
Brad Nelson, Symposium Technical Program Chair

(408) 616-5400

e-mail: bnelson@sirenza.com

Internet: www.gaasic.org/

2W & 5W DC to 18GHz ATTENUATORS

IN STOCK



\$29.95
from ea. (1-49)

Rugged Stainless Steel Construction, High Repeatability, Miniature Size, Low Cost, and Off-The-Shelf Availability are some of the features that make Mini-Circuits "BW" family of precision fixed attenuators stand above the crowd! This extremely broad band DC to 18GHz series is available in 5 watt Type-N and 2&5 watt SMA coaxial designs, each containing 15 models with nominal attenuation values from 1 to 40dB. Built tough to handle 125 watts maximum peak power, these high performance attenuators exhibit excellent temperature stability, 1.15:1 VSWR typical, and cover a wealth of applications. So contact Mini-Circuits today, and capture this next generation of performance and value!

Mini-Circuits...we're redefining what VALUE is all about!

MODELS (Add Prefix BW-)

2W SMA	5W SMA	5W Type-N	Attenuation (dB)	
			Nominal	Accuracy*
S1W2	S1W5	N1W5	1	±0.40
S2W2	S2W5	N2W5	2	±0.40
S3W2	S3W5	N3W5	3	±0.40
S4W2	S4W5	N4W5	4	±0.40
S5W2	S5W5	N5W5	5	±0.40
S6W2	S6W5	N6W5	6	±0.40
S7W2	S7W5	N7W5	7	±0.60
S8W2	S8W5	N8W5	8	±0.60
S9W2	S9W5	N9W5	9	±0.60
S10W2	S10W5	N10W5	10	±0.60
S12W2	S12W5	N12W5	12	±0.60
S15W2	S15W5	N15W5	15	±0.60
S20W2	S20W5	N20W5	20	±0.60
S30W2	S30W5	N30W5	30	±0.85
S40W2	S40W5	N40W5	40	±0.85

*At 25°C includes power and frequency variations up to 12.4GHz. Above 12.4GHz add 0.5dB typ. to accuracy.

DC-18GHz Adapters NOW AVAILABLE!

Type-N to SMA \$22.95 ea. (1-49) SMA-F to SMA-M \$8.95 ea. (1-49)



For detailed adapter specs visit: www.minicircuits.com/adapters.html

Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001 CERTIFIED

F 331 Rev B

Leaky Slot Antenna Array Suits Millimeter-Wave Applications

LEAKY-WAVE ANTENNA ARRAYS are attractive to system designers for their high directivity. Although a great deal of research has been performed on leaky-wave antenna arrays for microwave use, very little work has been done on the possibility of using this antenna architecture for millimeter-wave frequencies. For that reason, Anthony Grbic and George Eleftheriades of the Edward S. Rogers Senior Department of Electrical and Computer Engineering at the University of Toronto (Toronto, Ontario, Canada) proposed a leaky-wave structure that

is essentially a coplanar-waveguide (CPW) transmission line loaded with radiative, transverse series slots. The periodically loaded traveling-wave structure achieves excellent performance at 30 GHz (9.2-dB gain) with very low return loss from 26 to 36 GHz. The investigators fabricated both unidirectional and bidirectional versions of the antenna. For more information, see "Leaky CPW-Based Slot Antenna Arrays for Millimeter-Wave Applications," *IEEE Transactions on Antennas and Propagation*, November 2002, Vol. 50, No. 11, p. 1494.

Comparing Time- And Frequency-Domain Antenna Patterns

TO OVERCOME THE DIFFICULTY of modeling extremely large, space-based arrays, Leo DiDomenico of the Jet Propulsion Lab of the California Institute of Technology (Pasadena, CA) undertook a comparison of antenna patterns in both the time domain and the frequency domain. The author discovered that signifi-

cant improvement in pattern analysis is possible by working with time-gated short pulses and wavelets rather than simple narrowband sinusoidal patterns. See "A Comparison of Time versus Frequency Domain Antenna Patterns," *IEEE Transactions on Antennas and Propagation*, November 2002, Vol. 50, No. 11, p. 1560.

Compact Stripline Balun Aids Balanced Bluetooth Amplifiers

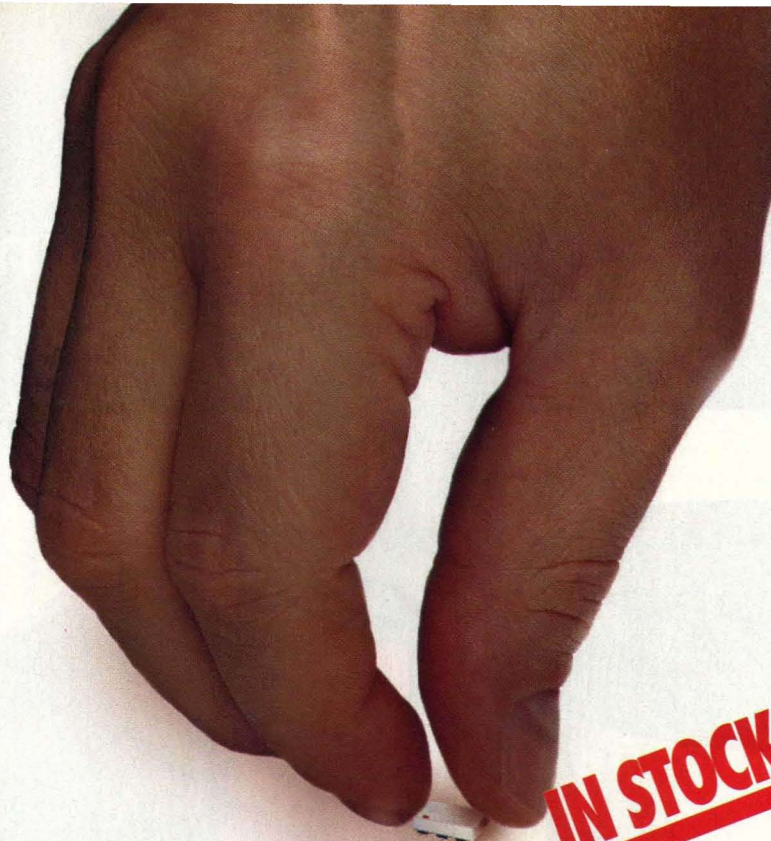
COMPACT BALUNS ARE ESSENTIAL for achieving the size, cost, and performance goals of certain wireless applications, such as 2.4-GHz Bluetooth devices. The balun is important since balanced (differential) power amplifiers are often used to increase the gain and range of Bluetooth systems, and these balanced amplifiers must be connected to the largely single-ended circuitry of Bluetooth designs. By using the Microwave Office software tools from Applied Wave Research (El Segundo, CA), Shu-Chuen Loo and Kim-Fung Tsang of the Department of Electrical Engineering of the City University of Hong Kong were able to perform analysis on a compact meandering stripline balun design fabricated on four-layer FR4 substrate material. As part of the balun design, a high-impedance bias line is used to provide power to the connected

power amplifier. The novel balun design was compared with a half-wave transmission-line balun for identical Bluetooth power amplifiers operating from 2.4000 to 2.4835 GHz. Although the meandering-line balun showed greater amplitude imbalance (about 2 dB) than the half-wave balun, the overall performance of the meandering-line stripline balun was encouraging, with better than 0.6-dB insertion loss improvement and better than 15-dB return loss improvement when compared to the half-wave balun. The small size of the novel balun makes it ideal for size-sensitive wireless designs, such as portable Bluetooth devices. See "A Novel Compact Meandering Stripline Balun for Balanced Amplifiers With Bluetooth Application," *Microwave and Optical Technology Letters*, December 20, 2002, Vol. 35, No. 6, p. 423.

Analyzing UWB Signals In A Typical Indoor Environment

UNDERSTANDING ULTRA WIDEBAND (UWB) signal propagation will be one of the keys to the success of this pulsed "carrierless" transmission format. For that reason, Guy Schiavone and associates from the School of Electrical Engineering and Computer Science at the University of Central Florida (Orlando, FL) conducted research on UWB signal propagation in a typical indoor environment. The researchers use the PulsON Application Demonstrator (PAD) kit (transmitter and receiver) from Time Domain Corp. in an office building where the

dimensions of the test room were carefully measured for calibration. A 2-GHz bandwidth centered at 1.9 GHz was used for the measurements, which revealed some shortcomings of UWB simulations. It was found that the transmitted power must increase in an almost linear function of distance from receiver to transmitter to maintain a given bit rate. See "Analysis of Ultra-Wide Band Signal Propagation in an Indoor Environment," *Microwave and Optical Technology Letters*, January 5, 2002, Vol. 36, No. 1, p. 13.



IN STOCK

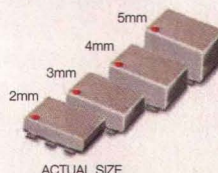
INNOVATIVE MIXERS

.smaller size .better performance .lower cost

50kHz to 4200MHz from **\$1.99** (ea. Qty.100)

it
innovative
technology

Searching high and low for a better frequency mixer? Then take a closer look at the Innovative Technology built into Mini-Circuits ADE mixers. **Smaller size** is achieved using an ultra-slim, patented package with a profile as low as 0.082 inches (2mm) in height. Electrically, ADE mixers deliver **better performance** than previous generation mixers through all welded connections with unique assembly construction which reduces parasitic inductance. The result is dramatically improved high frequency and IP2-IP3 performance. Plus, ADE's innovative package design allows water wash to drain and eliminates the possibility of residue entrapment. Another ADE high point is the **lower cost**...priced from only \$1.99 each. So, if you've been searching high and low for a mixer to exceed expectations...ADE is **it**™



ACTUAL SIZE

ADE Mixers...Innovations Without Traditional Limitations!

ADE* TYPICAL SPECIFICATIONS:

MODEL	LO Power (dBm)	Freq. (MHz)	Conv. Loss Midband (dB)	L-R Isol. Midband (dB)	IP3 @Midband (dBm)	Height (mm)	Price (\$ea. Qty. 10-49)
ADE-1L	+3	2-500	5.2	55	16	3	3.95
ADE-3L	+3	0.2-400	5.3	47	10	4	4.25
ADEX-10L	+4	10-1000	7.2	60	16	3	2.95
ADE-1	+7	0.5-600	5.0	55	15	4	1.99▲
ADE-1ASK	+7	2-600	5.3	50	16	3	3.95
ADE-2	+7	5-1000	6.67	47	20	3	1.99▲
ADE-2ASK	+7	1-1000	5.4	45	12	3	4.25
ADE-6	+7	0.05-250	4.6	40	10	5	4.95
ADEX-10	+7	10-1000	6.8	60	16	3	2.95
ADE-12	+7	50-1000	7.0	35	17	2	2.95
ADE-4	+7	200-1000	6.8	53	15	3	4.25
ADE-14	+7	800-1000	7.4	32	17	2	3.25
ADE-901	+7	800-1000	5.9	32	13	3	2.95
ADE-5	+7	5-1500	6.6	40	15	3	3.45
ADE-5X	+7	5-1500	6.2	33	8	3	2.95
ADE-13	+7	50-1600	8.1	40	11	2	3.10
ADE-11X	+7	10-2000	7.1	36	9	3	1.99▲
ADE-20	+7	1500-2000	5.4	31	14	3	4.95
ADE-18	+7	1700-2500	4.9	27	10	3	3.45
ADE-3GL	+7	2100-2600	6.0	34	17	2	4.95
ADE-3G	+7	2300-2700	5.6	36	13	3	3.45
ADE-28	+7	1500-2800	5.1	30	8	3	5.95
ADE-30	+7	200-3000	4.5	35	14	3	6.95
ADE-32	+7	2500-3200	5.4	29	15	3	6.95
ADE-35	+7	1600-3500	6.3	25	11	3	4.95
ADE-18W	+7	1750-3500	5.4	33	11	3	3.95
ADE-30W	+7	300-4000	6.8	35	12	3	8.95
ADE-1LH	+10	0.5-500	5.0	55	15	4	2.99
ADE-1LHW	+10	2-750	5.3	52	15	3	4.95
ADE-1MH	+13	2-500	5.2	50	17	3	5.95
ADE-1MHW	+13	0.5-600	5.2	53	17	4	6.45
ADE-10MH	+13	800-1000	7.0	34	26	4	6.95
ADE-12MH	+13	10-1200	6.3	45	22	3	6.45
ADE-25MH	+13	5-2500	6.9	34	16	3	6.95
ADE-35MH	+13	5-3500	6.9	33	18	3	9.95
ADE-42MH	+13	5-4200	7.5	29	17	3	14.95
ADE-1H	+17	0.5-500	5.3	52	23	4	4.95
ADE-1HW	+17	5-750	6.0	48	26	3	6.45
ADEX-10H	+17	10-1000	7.0	55	22	3	3.45
ADE-10H	+17	400-1000	7.0	39	30	3	7.95
ADE-12H	+17	500-1200	6.7	34	28	3	8.95
ADE-17H	+17	100-1700	7.2	36	25	3	8.95
ADE-20H	+17	1500-2000	5.2	29	24	3	8.95

Component mounting area on customer PC board is 0.320"x 0.290".
*Protected by U.S. patent 6133525. ▲100 piece price.

Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



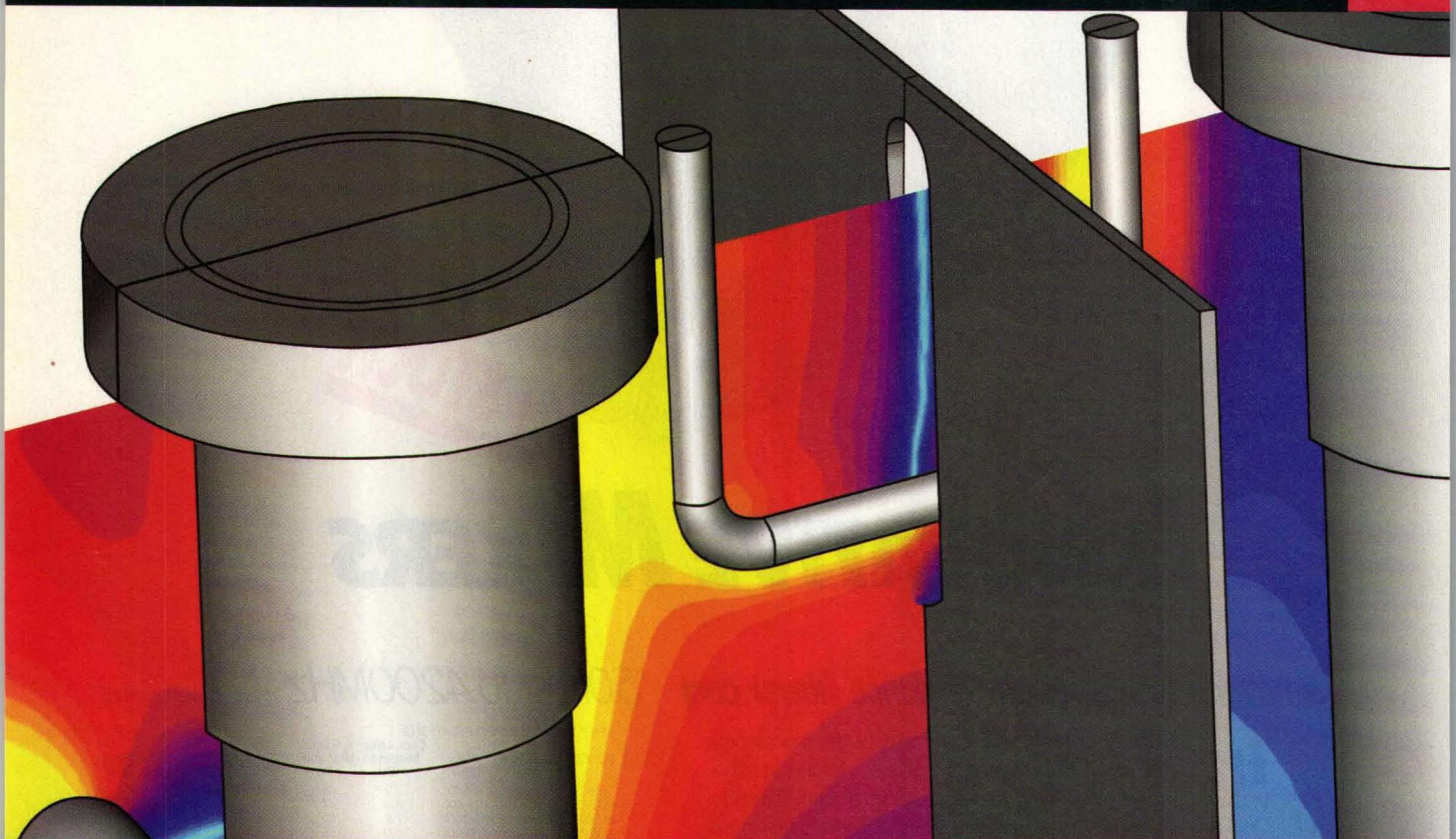
The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001 ISO 14001 CERTIFIED

267 Rev O

Still trying, tuning, trying again?

3D EM
Simulation



3D EM
Simulation

→ ... Prototyping and testing without simulating your design first can be very costly to your business. CST's virtual prototyping technology offers designers the benefit of mature parameterisation, parameter sweeps, and automatic optimisation which reduces cut-and-try iterations and so considerably speeds up time-to-market.

CST's award winning »STUDIO software family« is used world-wide by market leaders such as Motorola, Nokia, Philips, Raytheon, Siemens, and Sony. Typical applications include the simulation of antennas, coax and multipin connectors, couplers, LTCCs, MMIC packages, multiplexers, planar structures, power splitters, RLC-extraction, waveguides, and, of course, filters.

Connect yourself to CST's open design environment and experience the cutting edge of simulation technology. Get it right first time.

CST. CHANGING THE STANDARDS.

CST of America®, Inc.

To request literature or a free demo CD, © 781-416-2782, or info: www.cst-world.com

CST
COMPUTER SIMULATION
TECHNOLOGY



Meld Load-Pull Tests With EDA Tools

The limitations of large-signal device models can be overcome by effectively integrating load-pull measurement data into commercial EDA simulation tools.

Power-amplifier (PA) designers are often hampered in their use of electronic-design-automation (EDA) simulation tools because of deficiencies in large-signal models. Typically, an engineer must augment EDA tools with measured data before performing a simulation. This measurement can take the form of a few data points with a manual impedance tuner or it can be a full-fledged load-pull measurement. By

grow geometrically. Such swept load-pull measurements extend the design-cycle time because physical prototypes

carefully integrating load-pull measurements with EDA tools, it is possible to overcome the limitations of current large-signal device models and improve the overall process of designing PAs.

The load-pull measurement process is, of course, a method of applying known load states (impedances) to a RF power device and measuring pertinent performance attributes (i.e., power-out, efficiency, linearity, and input impedance). As parameters, such as frequency, drive power, supply voltage, and quiescent current, are swept during the measurements, the complexity and time required for the measurements

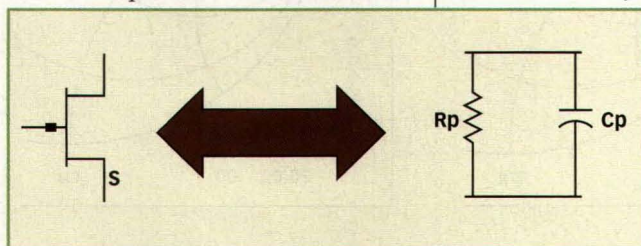
and measurements must be made to fill in the missing pieces for the EDA tools.

It is also not trivial to apply the load-pull data to an EDA tool. Typically, designers must translate data from the load-pull measurement domain to the simulation framework. Connecting the two environments generally involves selecting impedance "points" from either contours or tabular data from the measurement side and manually entering them into the simulation tool. This manual approach is suitable for a design with narrow performance criteria, but is unrealistic when multiple attributes (power out, efficiency, and linearity over bandwidth, drive-power, and bias

settings) are considered. Poor integration of load-pull data with EDA circuit-simulation tools is a major deficiency in the RF power design process. Designers require compre-

RICHARD L. CARLSON Distinguished Member of the Technical Staff

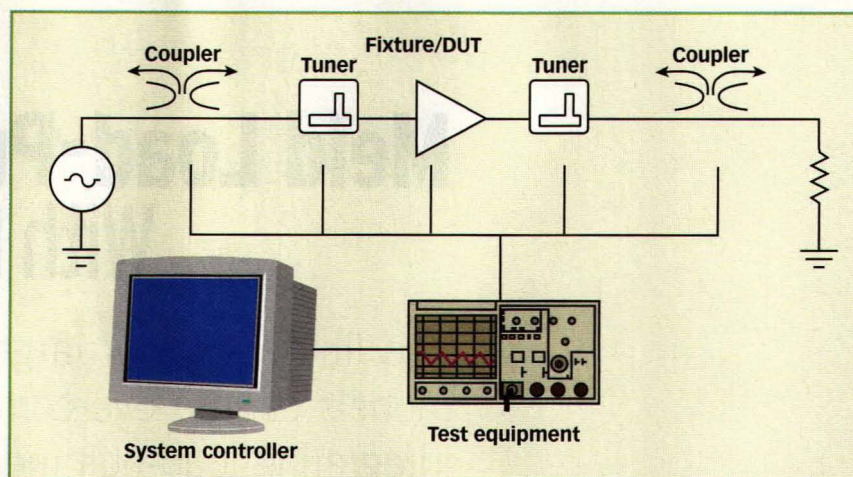
Motorola, Inc., Global Telecom
Solutions Sector, 1303 East Algonquin
Rd., Schaumburg, IL 60196; (847) 576-
4144, e-mail: CRC006@motorola.com,
Internet: www.motorola.com.



1. An unmatched power transistor operating below resonance can be approximately represented by this equivalent circuit.

hensive load-pull information (both dependent and independent variables) in their EDA tools. They want an effective RF power model that can be implemented into their simulation just like any other component model.

Major EDA tool and measurement system vendors are beginning to recognize the value of integrating load-pull data with modeling. Applied Wave Research (El Segundo, CA) introduced a load-pull wizard in their circuit simulator, Microwave Office 2002.¹ This capability facilitates viewing load-pull data and establishing load-pull simulations with device models. It also allows data files from commercial measurement systems to be integrated to the simulator versus load only. However, frequency, drive-power, and bias are fixed values making it difficult to assess performance over bandwidth or other operating parameters. The Advanced Design System (ADS) from Agilent Technologies (Santa Rosa, CA) provides the ability to generate behavioral models for simulation speed enhancements using the Load-pullSetup and AmpLoad-pull elements,² but these capabilities do not address the deficiencies of the high-power device models. Recently, Agi-



3. This system performs load-pull device measurements under computer control.

lent has announced the ability to import load-pull measurements in ADS2003.

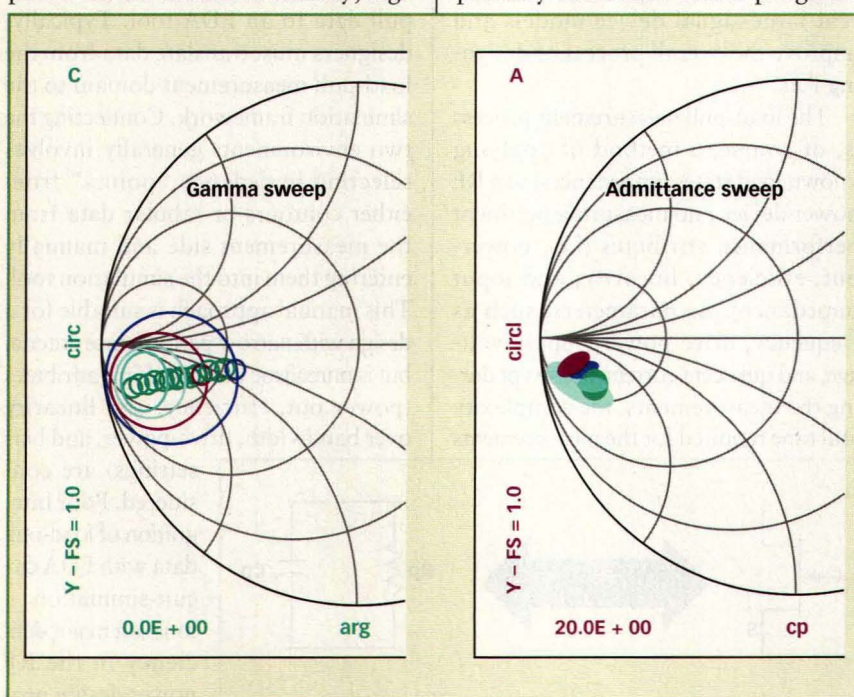
On the hardware side, Maury Microwave (Ontario, CA) markets a translator converting load-pull files to Agilent ADS.³ Little information is available, however, on the dimensionality of the data or on linking these data to the simulator. Focus Microwaves (Dollard-des-Oréamux, Quebec, Canada) offers the μ W-PADS⁴ and WinPADS⁵ software that use contours to drive circuit-matching networks using proprietary software. These programs

employ a limited set of lumped- and distributed-circuit elements that may be optimized based on load-pull measurements; unfortunately, the platform is a non-mainstream EDA environment specializing only in PA design.

Engineers within the Global Telecom Solutions Sector (GTSS) infrastructure equipment group of Motorola (SBCL—Schaumburg, IL) have long recognized the chasm between load-pull measurements and simulation tools. In the mid-1990s, a program was initiated to bridge the load-pull/simulation gap. A primary tenet of this program was to merge and analyze load-pull measurements within mainstream EDA tools. A load-pull measurement system was used to measure device data, not extensively analyze it. Data reduction was reserved for the EDA simulation domain through the use of network analysis and optimization. This vision was realized by:

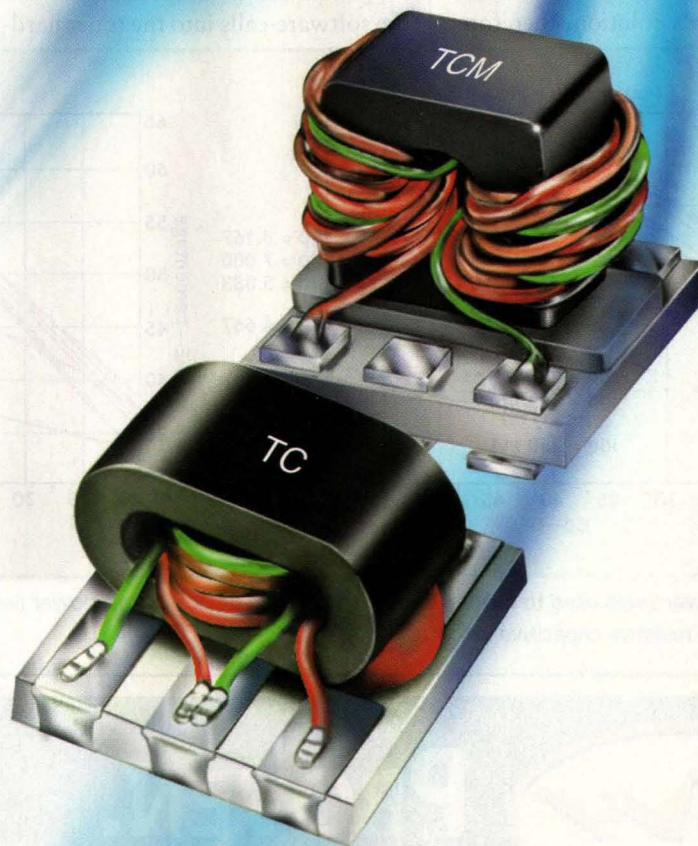
1. Extracting accurate load-pull data over a wide operating space including frequency, drive-power, bias, and load.
2. Integrating this entire measurement space into a database accessible to EDA design tools.
3. Developing simulation utilities to design RF PAs exploiting load-pull measurements.

The first two tasks are intertwined. Unfortunately, commercial load-pull systems have been unable to provide the multidimensional sweep in a format compliant with the EDA tools. In the



2. The gamma (Γ) and modified admittance sweep (right) methods are compared here.

RF TRANSFORMERS



.3-2500MHz as low as **99¢** **IN STOCK** each (qty. 100)

It used to be that small RF transformers with high end performance cost a lot, but not since Mini-Circuits introduced the all ceramic TC and high strength plastic TCM families. Now you can get impedance ratios from 0.1:1 to 16:1 ohms with good return loss and broad bandwidths from 0.3 to 2500MHz at price buster values. Plus, these ultra-small performers have all-welded, solder plated leads for highly reliable pick-up and solderability during automated assembly. So have it both ways; high performance AND low price with Mini-Circuits TC and TCM surface mount transformers.

Detailed Performance Data & Specs Online at: www.minicircuits.com/model

PLASTIC CASE

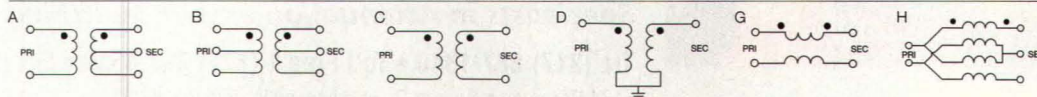
Model	Ω Ratio & Config.	Freq. (MHz)	Ins. Loss* 1dB (MHz)	Price \$ea. (qty. 100)
TCM1-1	1C	1.5-500	5-350	.99
TCML1-11	1G	600-1100	700-1000	1.09
TCML1-19	1G	800-1900	900-1400	1.09
TCM2-1T	2A	3-300	3-300	1.09
TCM3-1T	3A	2-500	5-300	1.09
TTCM4-4	4B	0.5-400	5-100	1.29
TCM4-1W	4A	3-800	10-100	.99
TCM4-6T	4A	1.5-600	3-350	1.19
TCM4-14	4A	200-1400	800-1000	1.09
TCM4-19	4H	10-1900	30-700	1.09
TCM4-25	4H	500-2500	750-1200	1.09
TCM8-1	8A	2-500	10-100	.99
TCM9-1	9A	2-280	5-100	1.19

CERAMIC CASE

Model	Ω Ratio & Config.	Freq. (MHz)	Ins. Loss* 1dB (MHz)	Price \$ea. (qty. 100)
TC1-1T	1A	0.4-500	1-100	1.19
TC1-1	1C	1.5-500	5-350	1.19
TC1-15	1C	800-1500	800-1500	1.29
TC1.5-1	1.5D	5-2200	2-1100	1.59
TC2-1T	2A	3-300	3-300	1.29
TC3-1T	3A	5-300	5-300	1.29
TC4-1T	4A	5-300	1.5-100	1.19
TC4-1W	4A	3-800	10-100	1.19
TC4-14	4A	200-1400	800-1100	1.29
TC8-1	8A	2-500	10-100	1.19
TC9-1	9A	2-200	5-40	1.29
TC16-1T	16A	20-300	50-150	1.59
TC4-11	50/12.5D	2-1100	5-700	1.59
TC9-1-75	75/8D	0.3-475	0.9-370	1.59

Dimensions (LxW): TCM .15" x .16" TC .15" x .15" * Referenced to midband loss.

ELECTRICAL CONFIGURATIONS



Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

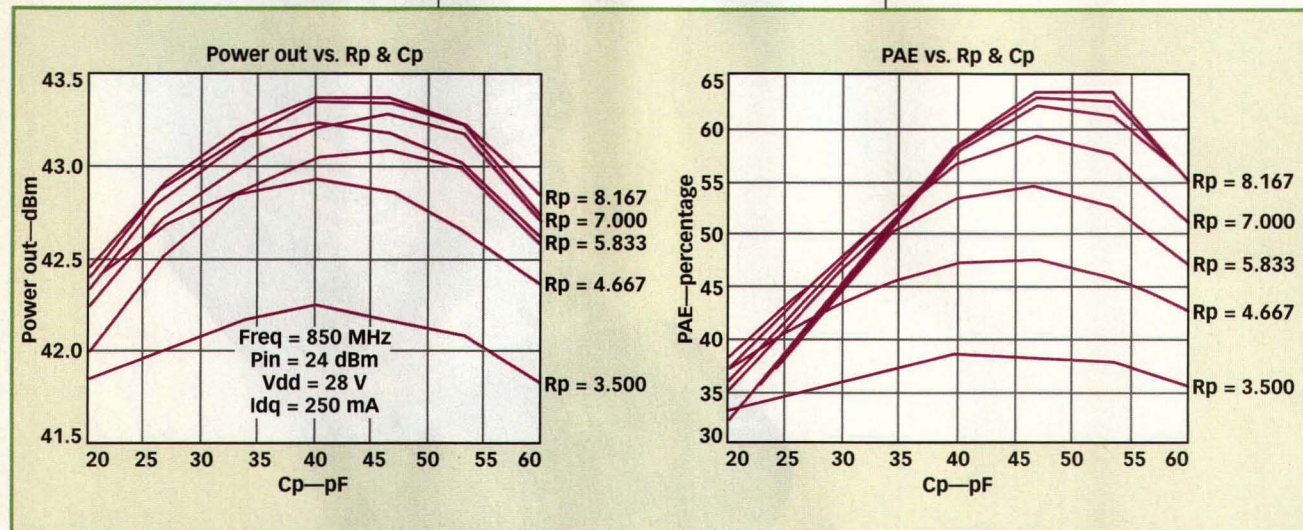
ISO 9001 ISO 14001 CERTIFIED

377 Rev. A

past, curve-fitting was applied to the data to achieve EDA tool compliance. However, with the addition of independent variables, curve-fitting becomes untenable. Motorola's solution, therefore,

was to acquire commercial load-pull hardware and internally develop custom control software. Focus Microwaves supplied tuner hardware and provided the software-calls into the tuner hard-

ware. Load-pull control software was written in Labview™ software from National Instruments (Austin, TX). These tools allowed the development of a semicustom system using professional-



4. The ADS software was used to display load-pull measured device output power (left) and power-added efficiency (right) as functions of the resistive-capacitive load $R_p C_p$.



PROVEN.



Now entering our fourth decade, JFW Industries is a **proven** leader in the design and production of innovative RF solutions. Whether your project calls for fixed **attenuators** and **terminations**, manually and electronically controlled **attenuators**, **RF switches**, **power dividers** or **programmable RF test**

systems and **switch matrices**; JFW's dedicated customer service and engineering personnel can provide application specific components and sub-systems at catalog prices with an off-the-shelf attitude. For more information please contact us or visit our website at www.jfwindustries.com

JFW Industries, Inc.

Specialists in Attenuation and RF Switching

TEL (317) 887-1340 • Toll Free 1 (877) 887-4539 • FAX (317) 881-6790

5134 Commerce Square Dr. • Indianapolis, Indiana 46237

Internet— <http://www.jfwindustries.com>

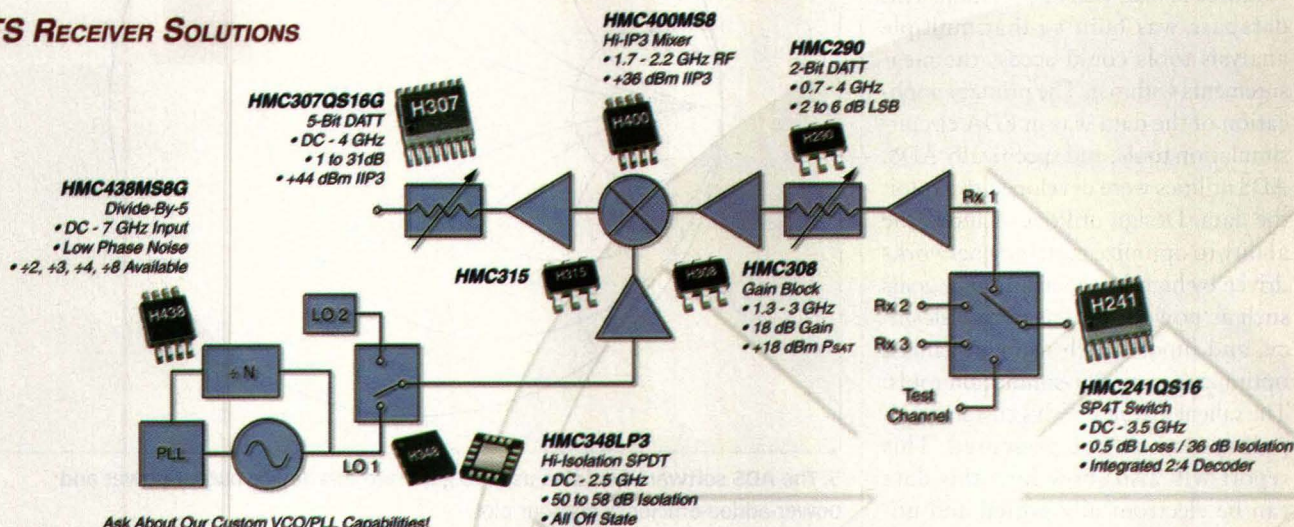
E-mail— sales@jfwindustries.com

ISO 9001 Certified

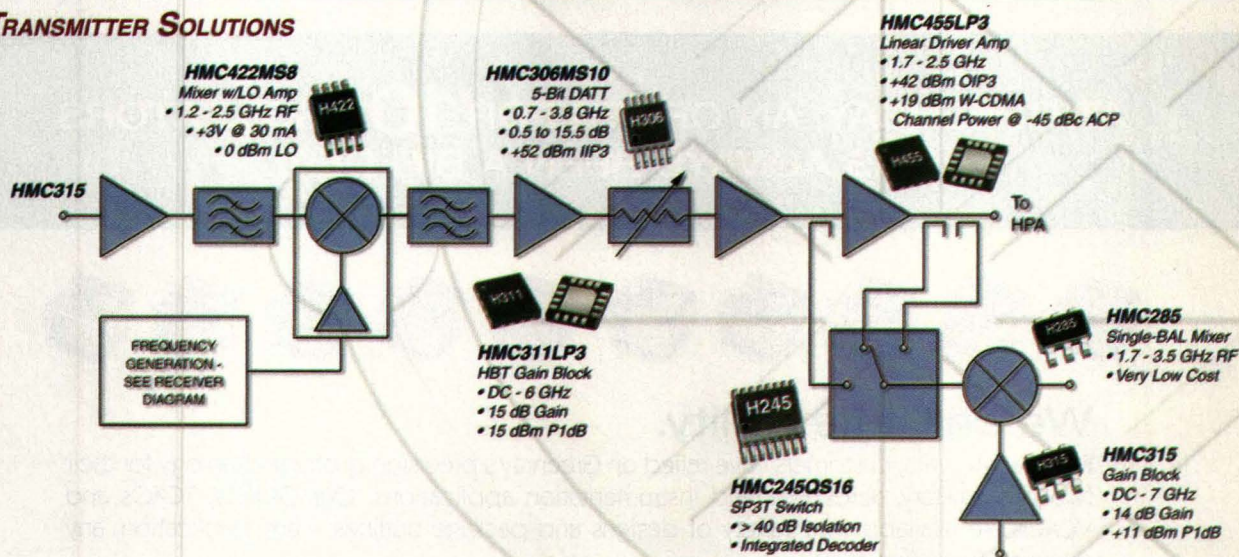
CELLULAR • UMTS/3G

BUILD YOUR BTS WITH THE BEST RFICs/MMICs!

BTS RECEIVER SOLUTIONS



BTS TRANSMITTER SOLUTIONS



Typical Cellular • UMTS / 3G applications are illustrated.
See the full product listing on www.hittite.com CELLULAR section.

ACTUAL SIZE

SOT26
9mm²



MS8(G)
14.8mm²



MS10(G)
14.8mm²



QS16(G)
29.4mm²



LP3
(QFN)
9mm²



Corporate Headquarters

12 Elizabeth Drive, Chelmsford, MA 01824
Ph (978) 250-3343 Fax (978) 250-3373 sales@hittite.com

World Wide Offices

HMC Europe, Ltd. Ph +44(0) 1256-817000 Fax +44(0) 1256-817111 europe@hittite.com
HMC Deutschland GmbH Ph +49 8031-97654 Fax +49 8031-98883 germany@hittite.com
HMC Asia Co., Ltd. Ph +82-2 559-0638 Fax +82-2 559-0639 asia@hittite.com

ORDER ON-LINE:
www.hittite.com

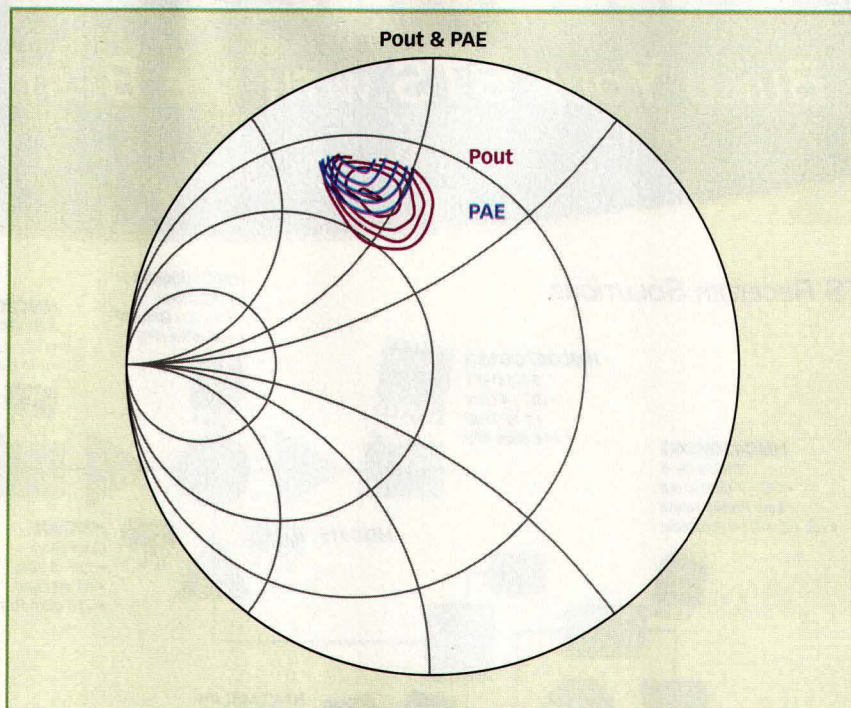


ISO 9001
Certified

Distributed in the Americas by Future Electronics Ph (800) Future-1, ext. 2754 www.futureelectronics.com/rf

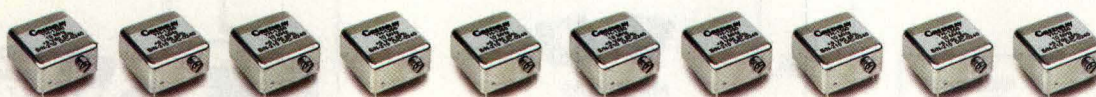
grade tuner hardware. Control of the sweep algorithms also assured that the resultant data structure was EDA compliant without the intermediate data conditioning.

Measurements from the control software permitted the construction of a database of load-pull information. This database was built so that multiple analysis tools could access the measurements within it. The primary application of the data was in EDA circuit-simulation tools, and specifically ADS. ADS utilities were developed to exploit the data. Design utilities included the ability to optimize matching networks driven by high-level performance goals such as power-out, linearity, efficiency, and input match using advanced optimizers in circuit-simulation tools. The salient features of this custom load-pull system will be presented. This report will also show how this data can be electronically ported and uti-



5. The ADS software was also used to generate this device output-power and power-added-efficiency contour plot.

AT GREENRAY, AN ORDER FOR 10 OSCILLATORS HAS ALWAYS BEEN A BIG DEAL.



We call it flexibility.

For over 40 years, customers have relied on Greenray's precision quartz technology for their telecom, military, aerospace and instrumentation applications. Our OCXOs, TCXOs and VCXOs are available in a variety of designs and package outlines – any application, any quantity. That's flexibility.

We offer ISO-9001 certification, extensive MIL-spec capabilities, custom build capability, in-house testing and our commitment to the highest standards for performance, reliability and customer service.

So whether you need just ten OCXOs or 10,000 – call us at **717-766-0223** or send us an e-mail at **sales@greenrayindustries.com**.

We're flexible – so you don't have to be.

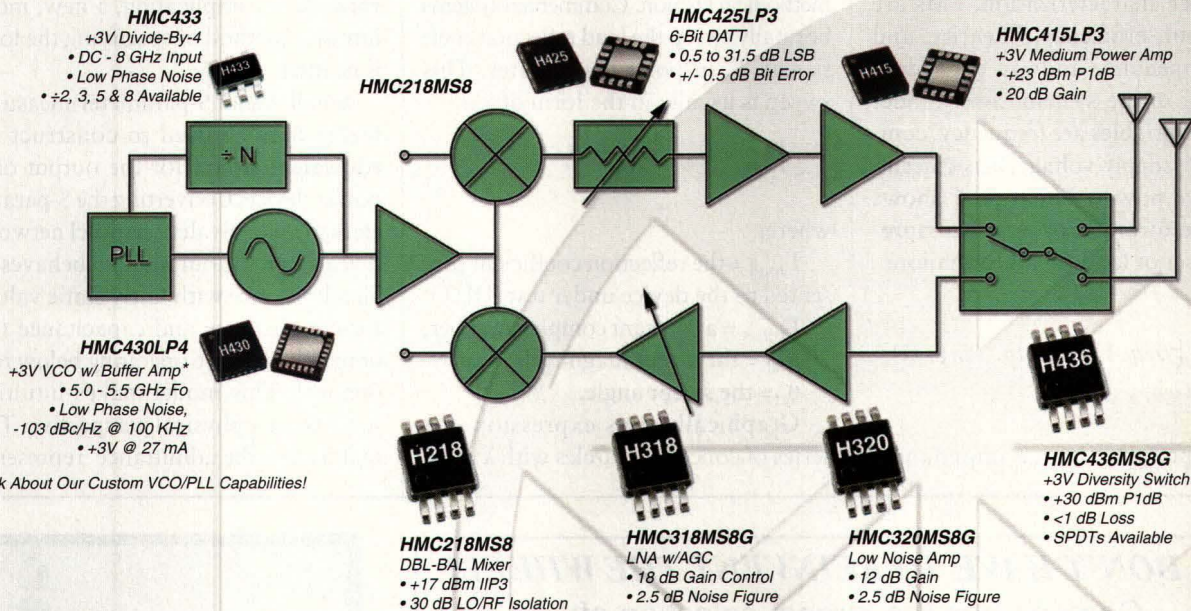
[[[www.greenrayindustries.com]]]



5 to 6 GHz RFICs

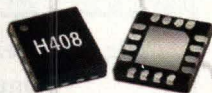
WIRELESSLAN, CORDLESS PHONES & UNII RADIOS

BUILDING BLOCK ICs FROM STOCK



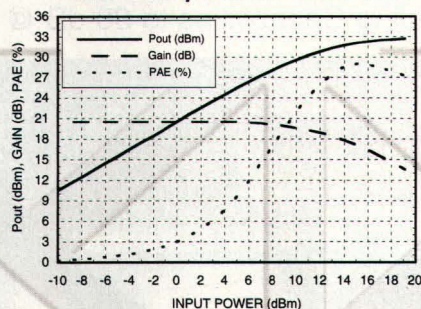
Contact Us for Custom RFICs and Multi-Chip Modules.

FEATURING! HMC408LP3 1 WATT InGaP HBT POWER AMPLIFIER



- 5.1 - 5.9 GHz
- 20 dB Gain
- Integrated Power Control
- Single +5V Supply
- 3x3mm QFN Package

Power Compression @ 5.8 GHz



See the full product listing on www.hittite.com BROADBAND section.

ACTUAL SIZE

SOT26
9mm²



MSOP8
14.8mm²



LP3
(QFN)
9mm²



LP4
(QFN)
16mm²



Corporate Headquarters

12 Elizabeth Drive, Chelmsford, MA 01824
Ph (978) 250-3343 Fax (978) 250-3373 sales@hittite.com

World Wide Offices

HMC Europe, Ltd. Ph +44(0) 1256-817000 Fax +44(0) 1256-817111 europe@hittite.com
HMC Deutschland GmbH Ph +49 8031-97654 Fax +49 8031-98883 germany@hittite.com
HMC Asia Co., Ltd. Ph +82-2 559-0638 Fax +82-2 559-0639 asia@hittite.com

ORDER ON-LINE:
www.hittite.com



ISO 9001
Certified

Distributed in the Americas by Future Electronics Ph (800) Future-1, ext. 2754 www.futureelectronics.com/rf

lized in an EDA circuit-simulation tool to design RF PAs. Examples will be provided using load-pull data of an MRF9045M (a 45-W output-power transistor) in the 700-to-1000-MHz band.

Load-pull measurements provide performance metrics (PM) on a device under numerous stimulus states. For RF power characterization, PMs are power-out, efficiency, linearity, and input impedance and are dependent variables in the system. Swept independent variables are frequency, complex load, supply-voltage, bias-current, and drive-power. Equation 1 shows the basic formulation for a comprehensive set of load-pull information:

$$PM \propto f\{freq, \Gamma, Vdd, Id, Pin\} \quad (1)$$

(Swept input-image impedance,

source-pull, may be implemented, but is not considered here. Harmonic terminations are not presently supported in this system. Both input-image impedance and harmonic terminations have secondary effects on their PMs.) Complex load, Γ , can be decomposed into two scalars yielding six independent variables that must be swept in a methodical fashion. Commercial systems normally sweep the load reflection coefficient, Γ , in polar coordinates. This sweep is usually in the form of:

$$\Gamma_{load} = \Gamma_{offset} + |\Gamma_s| \angle \theta_s \quad (2)$$

where:

Γ_{load} = the reflection coefficient presented to the device under test (DUT),

Γ_{offset} = a constant complex number,

$|\Gamma_s|$ = the swept magnitude, and

θ_s = the swept angle.

Graphically, this expression is a series of concentric circles with a fixed

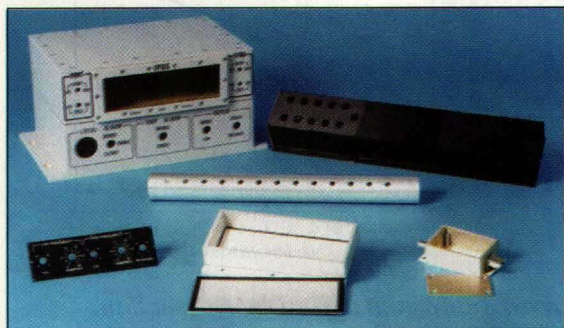
offset from the center of the Smith Chart. Over a narrow band, this specification may be adequate. However, over a wide band the Γ_{offset} should change over frequency to keep the load at or near the peak performance region requiring that Γ_{offset} be swept also. Since the Γ_{load} specification method is not very insightful and the addition of a third swept variable is complicating, a new, more intuitive method of specifying the load is needed.

Small-signal S-parameter measurements may be used to construct an equivalent circuit for the output of a power device. Converting the S-parameters to an equivalent parallel network reveals that the output load behaves as an admittance with fairly static values for conductance and capacitance (an unmatched device operating below resonance). This model makes intuitive sense from a physical perspective. The real part of the admittance represents

YOU DON'T HAVE TO REINVENT THE WHEEL!

Compac has the largest selection of:

- ✓ High Quality Low Cost
- ✓ Full Custom Manufacturing
- ✓ Off the Shelf Shielded Enclosure
- ✓ Shielding Capabilities to 80 dB @ 20 GHz



From Prototype Thru Production



Shielding Specialists

Tel: (631) 585-3400 • Fax: (631) 585-3534

Visit our Website: www.compac-rf.com



Big filter design problems
require the

BIG GUNS
in CAD software

Serious filter design software from
ALK Engineering

DGS S/FILSYN

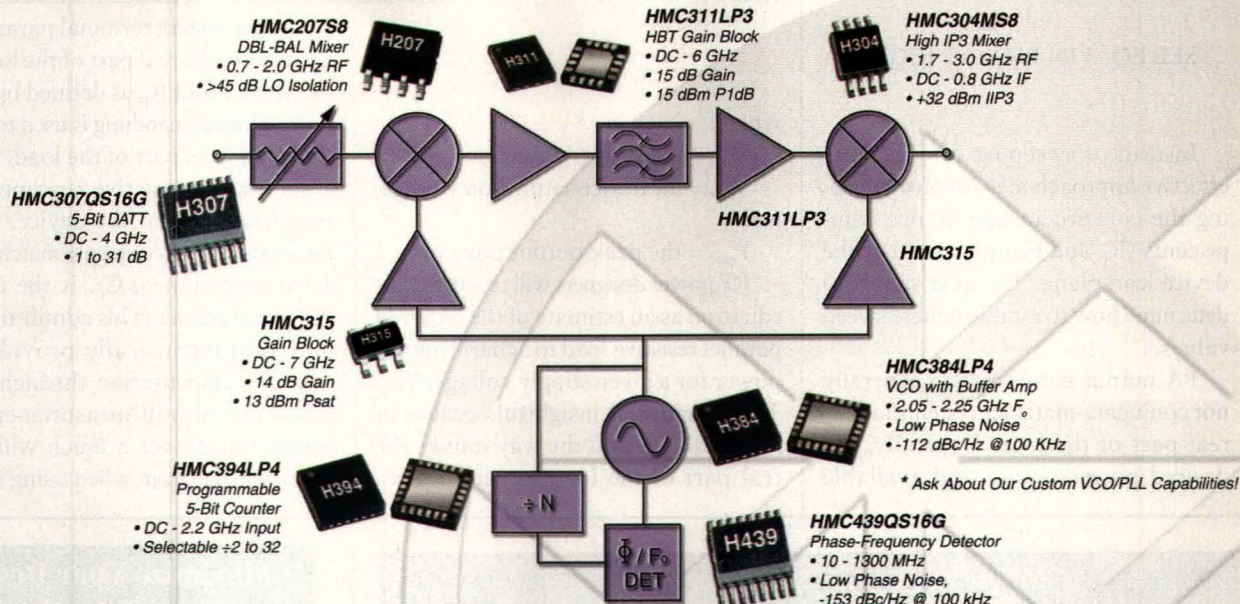
PCFILT

All new versions for
Windows 98/NT/2000/XP
<http://www.alkeng.com>
(410) 546-5573

BROADBAND CABLE

HIGH DYNAMIC RANGE RFICs FOR CABLE MODEM & CATV!

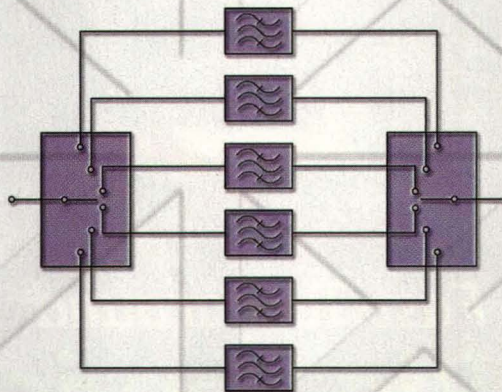
CABLE MODEM TERMINATION SYSTEM (CMTS)



CATV FILTER & SIGNAL ROUTING

A Selection of SPNT Switches

	Part Number	Frequency (GHz)	Function	1 GHz Loss / Isolation (dB)
NEW!	HMC348LP3	DC - 2.5	SPDT, 75 Ω	0.6 / 58
	HMC347LP3	DC - 15	SPDT	1.4 / 65
NEW!	HMC245QS16	DC - 3.5	SP3T	0.5 / 44
	HMC345LP3	DC - 8	SP4T	2.0 / >50
	HMC252QS24	DC - 3	SP6T	2.0 / >45
	HMC321LP4	DC - 8	SP8T	2.0 / >45



Typical Broadband Cable applications are illustrated.
See the full product listing on www.hittite.com BROADBAND section.

ACTUAL SIZE

SOT26
9mm²



MS8(G)
14.8mm²



S8(G)
29.4mm²



QS16(G)
29.4mm²



LP3
(QFN)
9mm²



LP4
(QFN)
16mm²



Corporate Headquarters

12 Elizabeth Drive, Chelmsford, MA 01824
Ph (978) 250-3343 Fax (978) 250-3373 sales@hittite.com

World Wide Offices

HMC Europe, Ltd. Ph +44(0) 1256-817000 Fax +44(0) 1256-817111 europe@hittite.com
HMC Deutschland GmbH Ph +49 8031-97654 Fax +49 8031-98883 germany@hittite.com
HMC Asia Co., Ltd. Ph +82-2 559-0638 Fax +82-2 559-0639 asia@hittite.com

Distributed in the Americas by Future Electronics Ph (800) Future-1, ext. 2754 www.futureelectronics.com/rl

ORDER ON-LINE:
www.hittite.com



FET resistance R_{ds} while multiple drain (collector) cells formulate a shunt capacitance. An unmatched LDMOS device, for example, appears to be well represented by a parallel R_p and C_p model. Equation 3 shows the admittance formula for a parallel $R_p C_p$ network while Fig. 1 shows this trivial circuit:

SEE EQ. 3 IN BOX AT RIGHT

Instead of sweeping of Γ , a more effective approach may involve sweeping the constituent admittance components (R_p and C_p) presented at the device lead plane. The next step is to determine how to establish these sweep values.

PA output networks are generally not conjugate-matched systems for the real part of the load. Typically, the desired power output and available

supply voltage determine the real part of the load presented to the device, not the device impedance. Equation 4 shows the classical approximation for the real part of the load:

SEE EQ. 4 IN BOX AT RIGHT

where:

V_{dd} = the supply voltage,

V_{sat} = the device saturation voltage, and

P_{out} = the peak output power.

RF power designers will recognize this equation as an estimate of the required parallel resistive load to achieve output power for a given supply voltage, V_{dd} . This equation is insightful because of its familiarity and the way it links the real part of the load to actual mea-

$$Y_{device} = \frac{G + j \times B = 1}{R_p + j\omega C} \quad (3)$$

$$R_p = \frac{((V_{dd} - V_{sat})^2)}{(2 \times P_{out})} \quad (4)$$

$$PM \propto f\{freq, R_p, C_p, V_{dd}, Id, Pin\} \quad (5)$$

surement system terminal parameters. Therefore, the real part of the load will be swept about R_p as defined by Eq. 4.

Conjugate matching is used to define the imaginary part of the load. As Fig. 1 shows, a capacitive susceptance is seen looking into the device. Therefore, to achieve a conjugate match, a negative capacitance, C_p , is the desired swept parameter. This admittance formulation intrinsically provides frequency compensation through the Ω scalar. Load-pull measurements are center tuned over a much wider frequency range than when using the fre-



Fast Turnaround

Big Service

HIGH QUALITY

SSI
Cable Corp.

Quality • Delivery • Value • Innovation

820 E. Hiawatha Blvd • Shelton, WA 98584 • tel: 360.426.5719 • www.ssicable.com

Coaxial Cable Assemblies

Semirigid

Copper

Aluminum

Stainless Steel

(Low cost alternative to SiO₂)

Flexible

Conformable

(In Stock for Immediate Delivery)

Phase Matched

Delay Lines

Low Loss

Wireless Preps

Wire Harness

Maximize Your Design Capabilities With

Filter Solutions®

www.filter-solutions.com

Powerful Affordable PC Based Software to Perform Your Most Complex Passive, Tx Line, Active and Digital Filter Design Tasks

FREE 20 DAY TRIAL

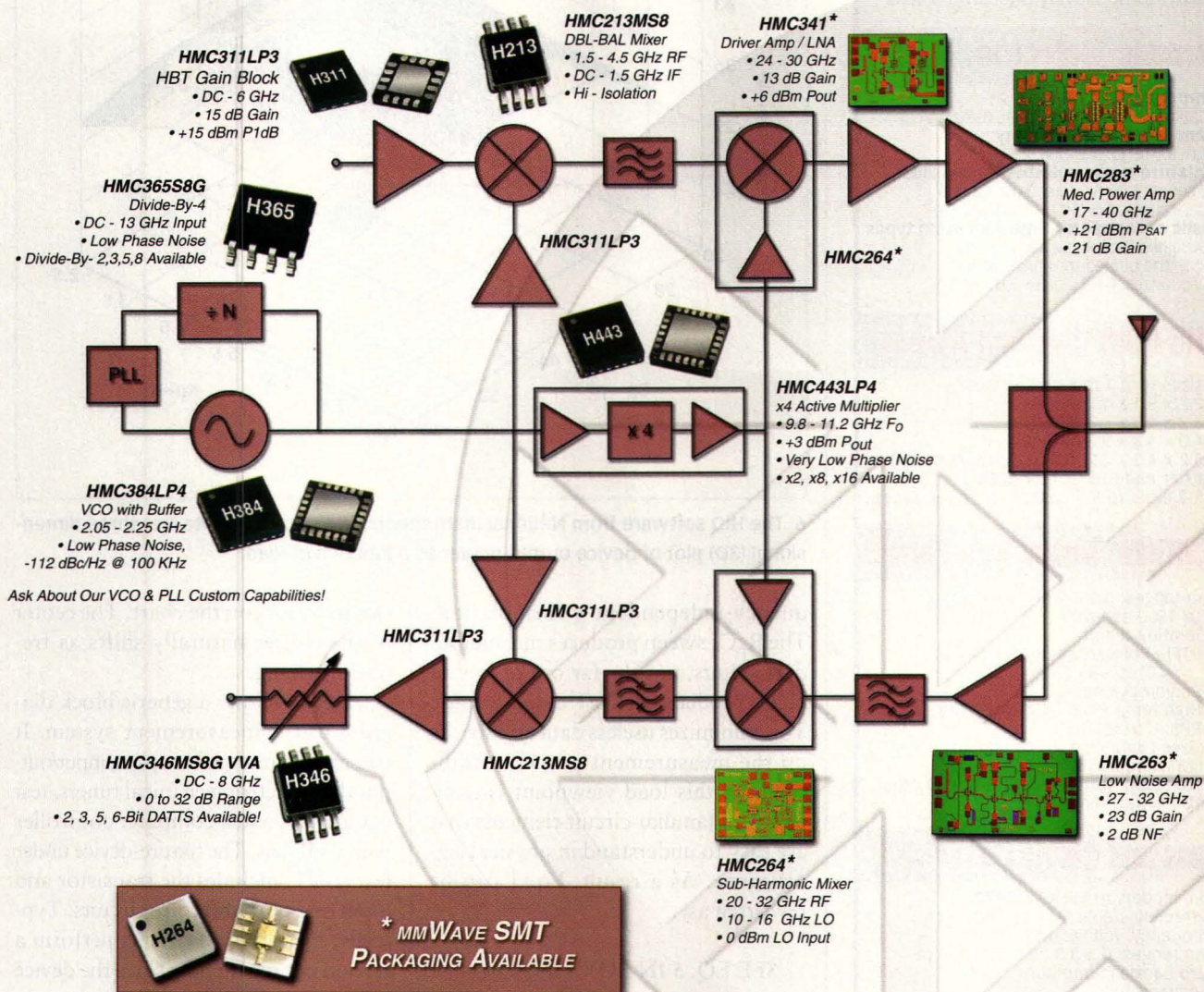
- High Order Elliptic Filters
- Diplexers
- Finite Q Analysis
- Delay Equalization Capability
- IIR and FIR Digital Filters
- Automatic C Code Generation
- Easy to Read and Modify Graphical Outputs

Nuhertz Technologies™

602-206-7781

POINT-TO-POINT & VSAT

MICROWAVE & MMWAVE MMIC SOLUTIONS 2 TO 42 GHz!



See our full product listing at www.hittite.com MICROWAVE section.
Hittite has your complete Point-to-Point/Multi-Point, VSAT & Sensor Circuit building blocks!

ACTUAL SIZE

MS8(G) 14.8mm²

S8(G) 29.4mm²

LP3 (QFN) 9mm²

LP4 (QFN) 16mm²

LM1 25.8mm²



Corporate Headquarters
12 Elizabeth Drive, Chelmsford, MA 01824
Ph (978) 250-3343 Fax (978) 250-3373 sales@hittite.com

World Wide Offices
HMC Europe, Ltd. Ph +44(0) 1256-817000 Fax +44(0) 1256-817111 europe@hittite.com
HMC Deutschland GmbH Ph +49 8031-97654 Fax +49 8031-98883 germany@hittite.com
HMC Asia Co., Ltd. Ph +82-2 559-0638 Fax +82-2 559-0639 asia@hittite.com

ORDER ON-LINE:
www.hittite.com



Distributed in the Americas by Future Electronics Ph (800) Future-1, ext. 2754 www.futureelectronics.com/rf

Trimmer Capacitors Since 1972

Sprague-Goodman has kept its commitment through the years to provide the industry with the highest quality, competitively priced trimmers.

Ceramic Dielectric

5 mm Rugged:

- Cap ranges: 1.5-5.5 pF to 15.0-90.0 pF

5 mm and 7 mm Economy:

- 1.0-3.0 pF to 14.0-108.0 pF

Miniature types suitable for hybrids

- 2 series: 2.0 x 1.2 mm; 3.0 x 1.8 mm
- Cap ranges: 1.0-3.0 pF to 6.0-40.0 pF

Plastic encased 4x4.5 mm and 6 mm types

- Designed for volume applications
- SMT and printed-thru-hole models
- Cap ranges: 14-3.0 pF to 20.0-90.0 pF

SURFTRIM® Surface Mount

- 4 sizes with 7 mounting styles:

- 2.2 x 3.1 x 1.2 mm
- 3.2 x 4.5 x 1.8 mm
- 4.0 x 4.5 x 2.7 mm (sealed)
- 5.2 x 4.3 x 3.2 mm (sealed split stator)

- Carrier and reel or bulk pack
- 0.5-2.0 pF to 8.5-50.0 pF in 17 cap ranges

FILMTRIM® Single Turn Plastic

- Cap ranges: 0.5-4.5 pF to 25-600 pF
- Q to 1500 at 1 MHz

Operating temp:

- PTFE, Polycarbonate, Polyimide: -40° to +85°C
- Polypropylene: -40° to +70°C
- High temp PTFE: -40° to +125°C
- PPS: -25° to +85°C

- 8 sizes from 5 mm to 16 mm, including 4 SMT models
- More stable with temperature than other single turn trimmers

Glass and Quartz PISTONCAP®

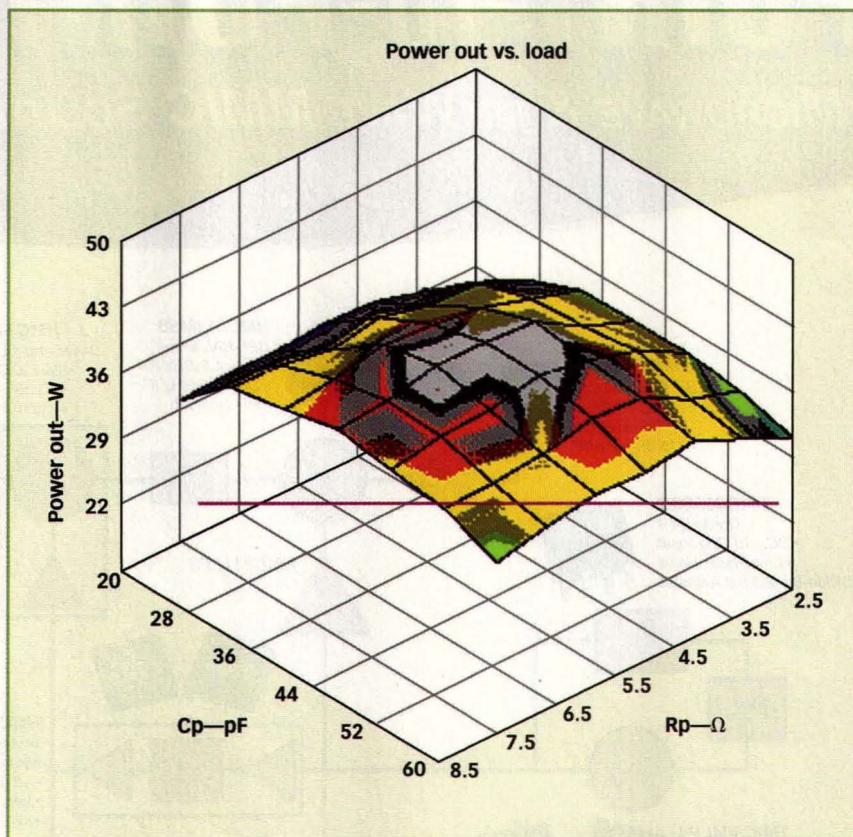
- QPL models to MIL-C-14409D
- Extremely stable over temperature, frequency, voltage, etc.
- Cap ranges: 0.5-3.0 pF to 1.0-120 pF
- Zero backlash multiturn adjust mechanism
- Operating temp: -55° to +125°C (models to +200°C)
- Q to 1500 at 20 MHz
- PC, panel and surface mounting
- Voltage ratings from 500 to 5000 V

For information on our complete line of trimmers and other quality products, visit our website, or phone, fax or write today.

**SPRAGUE
GOODMAN**

1700 Shames Drive, Westbury, NY 11590
Tel: 516-334-8700 • Fax: 516-334-8771
www.spraguegoodman.com

DESIGN



6. The HiQ software from National Instruments was used to create this three-dimensional (3D) plot of device output power as a function of load.

quency-independent γ formulation. The $R_p C_p$ sweep produces meaningful data points, not the far out of bound points produced by the Γ at some states. This minimizes useless data and speeds up the measurement process. Additionally, this load viewpoint is comprised of familiar circuit elements that are easy to understand in physical significance. As a result, Eq. 1 can be rewritten as:

SEE EQ. 5 IN BOX ON P. 60

This is the sweep and order method used in the Motorola load-pull system. This is also the equation that will be linked to the EDA tools described later. (This load formulation can be generalized for nonconstant R_p and C_p in the case of an internally matched device or where package parasitic elements are influential.) Figure 2 compares the Γ and admittance sweep differences on the Smith Chart. Parameter $R_p C_p$ is swept across the constant conductance cir-

cles in sectors on the chart. The center of the cluster naturally shifts as frequency changes.

Figure 3 shows a generic block diagram of the measurement system. It consists of directional couplers, input/output (I/O) electromechanical tuners, test equipment, and a computer controller with GPIB bus. The fixture-device under test (DUT) includes the transistor and input and output fixture circuits. Typically, these fixture circuits perform a section of prematching since the device I/O impedances are extremely low.

Measurements are referenced at the device lead plane including the performance and the swept independent variables. To accomplish this, circuitry leading to/from the device lead plane to the respective directional coupler is carefully characterized prior to load-pull measurements. Two-port tuner S-parameters are read and interpolated at each load state. The fully characterized system permits de-embedded measurements at the device lead plane. Power-

MILITARY & SPACE

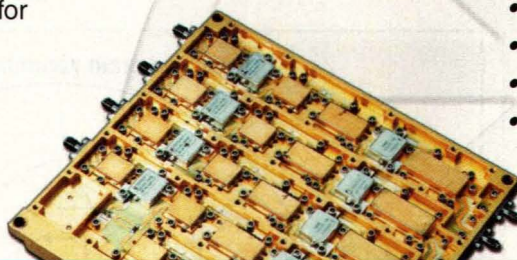
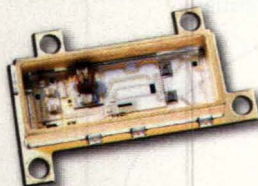
HIGH RELIABILITY MMICs FOR LAND, SEA & AEROSPACE!

MILITARY LEVEL & Hi-REL COMMERCIAL COMPONENTS & ASSEMBLIES

Hittite Microwave performs Class B screening on standard & custom product die and packaged die including SMT plastic encapsulated devices for COTS applications.



We design, produce and screen highly integrated MIC sub-assemblies for major defense OEMs.



CLASS B MIL-STD-883 SCREENING

- VI to Method 2010B & 2017B
- Bond Pull & Die Shear Test
- Solderability Test
- High Temp Burn-In Test
- Vibration Stress Test
- Temp Cycle Stress Test
- Constant Acceleration Stress Test
- Fine & Gross Hermeticity Test
- Serialized Test Data
- ESD Characterization

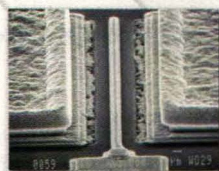
SPACE LEVEL COMPONENTS

CLASS S MIL-STD-883 SCREENING & QUALIFICATION

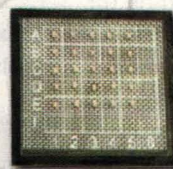
- VI to Methods
2010A & 2017S
- Temp Cycle Stress Test
- High Temp Burn-In & Life Test
- Wafer Lot Acceptance Test
Bond Pull & Die Shear Test
SEM Inspection
Metal & Glass Thicknesses
- Serialized Test Data
- Qualification Report

Hittite Microwave offers Class S screening on standard & custom product die and select hermetic packaged devices.

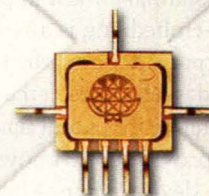
We are qualified by major spacecraft OEMs worldwide, shipping tens of thousands of S-Level components which are currently operational on dozens of commercial, scientific & military spacecraft.



FET Channel SEM



Serialized Die
in GEL-PAK



Hermetic
SMT Package

Contact us today with your high reliability requirements!

 **Hittite**
MICROWAVE CORPORATION

Corporate Headquarters

12 Elizabeth Drive, Chelmsford, MA 01824
Ph (978) 250-3343 Fax (978) 250-3373 sales@hittite.com

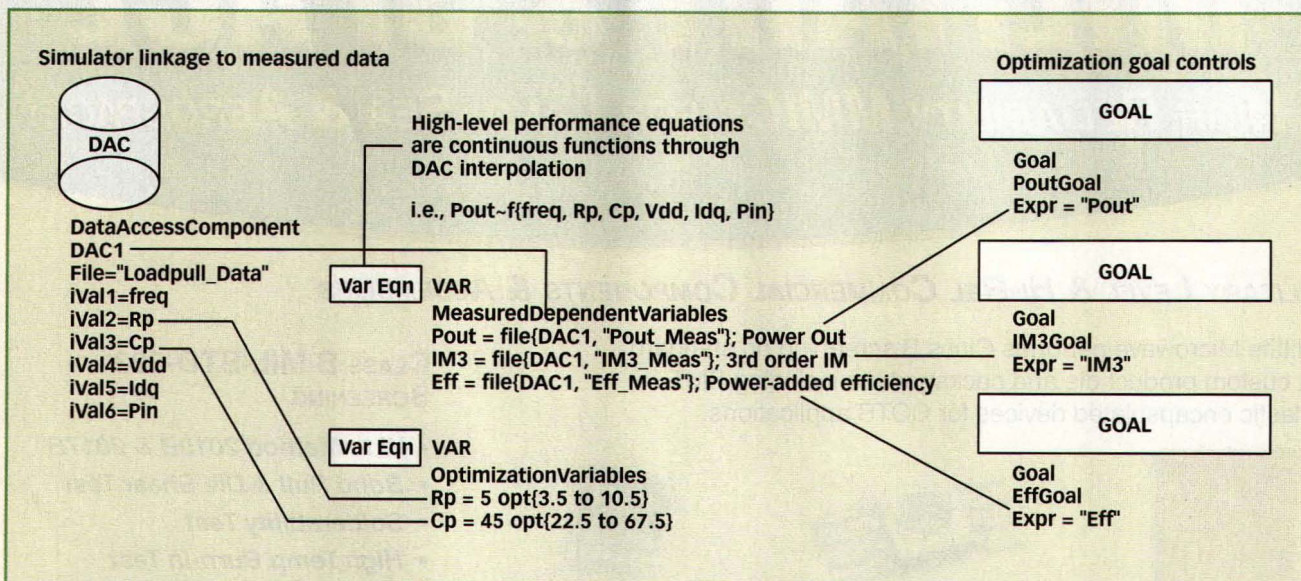
World Wide Offices

HMC Europe, Ltd. Ph +44(0) 1256-817000 Fax +44(0) 1256-817111 europe@hittite.com
HMC Deutschland GmbH Ph +49 8031-97654 Fax +49 8031-98883 germany@hittite.com
HMC Asia Co., Ltd. Ph +82-2 559-0638 Fax +82-2 559-0639 asia@hittite.com

ORDER ON-LINE:
www.hittite.com



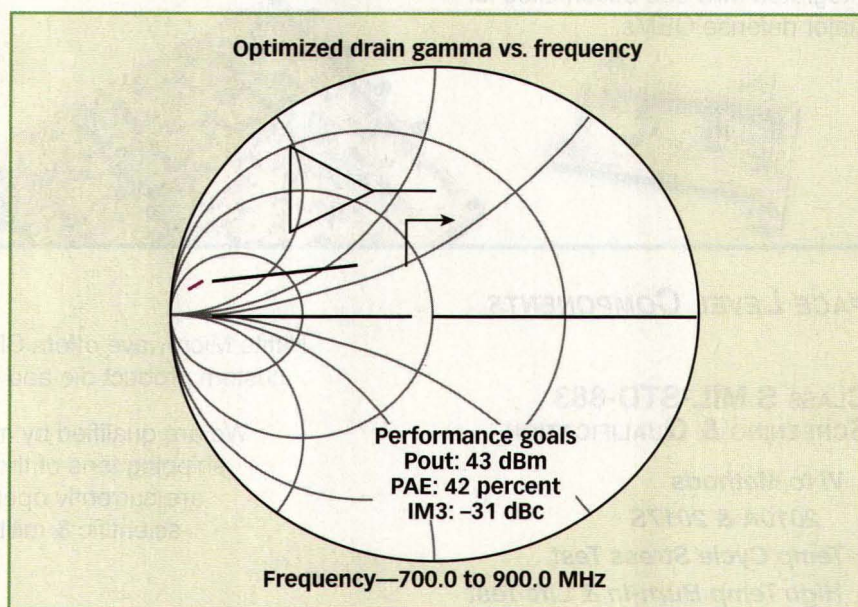
Distributed in the Americas by Future Electronics Ph (800) Future-1, ext. 2754 www.futureelectronics.com/rf



7. This ADS schematic excerpt illustrates the optimization setup to extract impedance at specified output-power, efficiency, and third-order-intercept points.

in is also referenced at the lead plane. At each test state in the six dimensional sweep, the input tuner is set to achieve a conjugate match (or as desired if applying source-pull) at the input-tuner-fixture/DUT plane. Device input impedance is then calculated since a calibrated vector network analyzer (VNA) is part of the test equipment. With the knowledge of the device input impedance, system input losses are calculated and the drive signal is compensated to overcome tuner and matching losses. Thus, the drive power independent variable is referenced at the device plane and independent of the dynamic circuit losses (which can be substantial for low impedance devices). De-embedding is also required on the output side to set the tuner. The $R_p C_p$ load is referenced at the device plane and therefore the output tuner Γ is calculated to provide these known loads back at the device plane. Eliminating all fixture dependencies is critical when the goal is to capture device performance only.

The measurement system is capable of reading power-out, current drain, linearity, and input impedance. Efficiency can be calculated from these measurements and the independent variables. The test-signal source (a dual arbitrary signal generator) can produce



8. Extracted impedance loci were taken from 700 to 900 MHz for the performance goals noted.

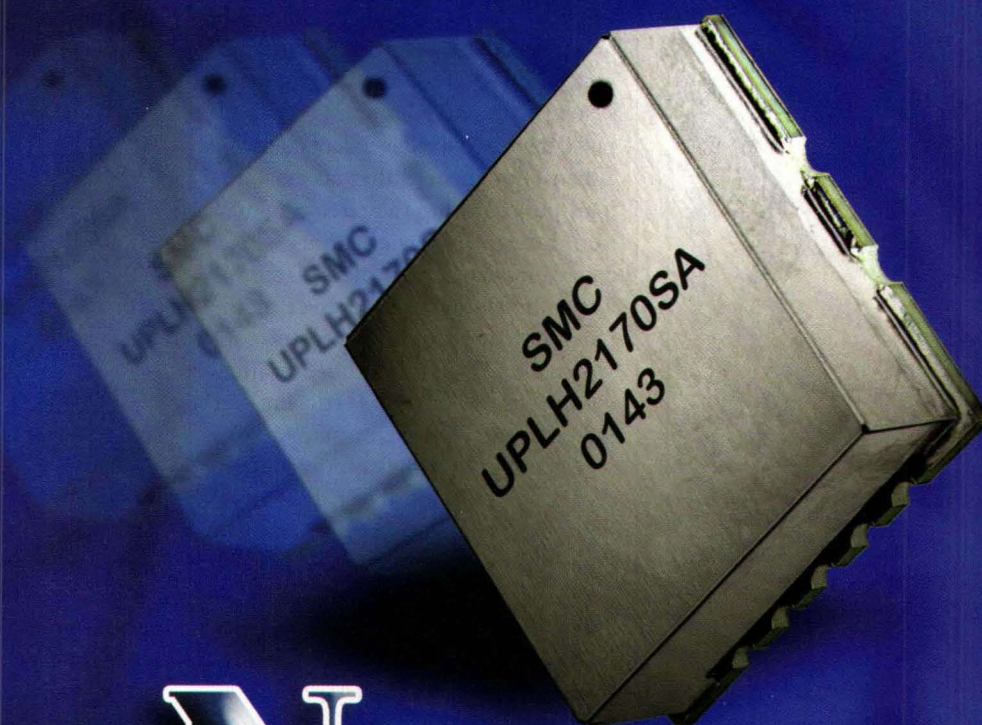
CW, two-tone, or complex modulation waveforms. A vector signal analyzer can assess linearity in terms of intermodulation distortion (IMD) or adjacent-channel coupled power ratio (ACCPR). Once a load-pull measurement is completed over the six independent variables, test data are stored in a database where they can be extracted by multiple analysis software such as visualization tools or circuit simulators.

Hewlett-Packard Co. (now Agilent

Technologies) developed the CITIfile (Common Instrumentation Transfer and Interchange) format for computer/instrumentation data exchange and subsequently adopted it to the MDS and ADS EDA tools. CITIfile is suited for load-pull data since it can support an arbitrary number of dependent and independent variables. One requirement is that the independent variables must be methodically swept—that is, the same inner values of the sweep must be

UMTS / CDMA-3G Band **SYNTHESIZER**

- ◆ 2110 to 2170 MHz
- ◆ Exceptional Phase Noise
- ◆ Compact Size
- ◆ Optimized Reference Sidebands



New

*For additional information, contact Synergy's sales and application team.
201 McLean Boulevard, Paterson, NJ 07504
Phone: (973) 881-8800 Fax: (973) 881-8361 E-mail: sales@synergymwave.com
World Wide Web: <http://www.synergymwave.com>*



**See Us At MTT-S Show
Booth #2218**

TELECOM AMPLIFIERS



RF and Microwave Low Noise Amplifiers
High Dynamic Range Amplifiers
Dividers / Combiners
Integrated Subsystems
Medium Power Amplifiers
Multicouplers
Up / Down Converters

CAP Wireless

(805) 499-1818
www.capwireless.com

DESIGN

identical. In the measurement system presented here, the order of the independent variables is frequency, R_p , C_p , supply voltage, bias current, and drive-power. Thus, for each frequency, the five independent variables below it must take on the same values to be CITIfile compliant. (The frequency tracking benefit of the $R_p C_p$ load descriptor becomes clear.) Before the development of the present measurement system, load-pull CITIfiles were built by curve-fitting measurements. Curve-fitting added an additional step, which became very difficult to implement with additional independent variables. The customized measurement system is compatible with CITIfile by system design, and therefore no intermediate mathematical manipulation is required. The measurement system automatically places the load-pull data in a tool independent database. When a designer requires access to the load-pull data for the circuit simulation, a custom Labview utility is executed allowing perusal of the database. The utility allows the user to select the pertinent operating space and constructs a CITIfile about those terminal conditions. Next, the CITIfile must be linked to the EDA environment.

Agilent EDA tools support the concept of a DATASET object. This object holds either simulation information or data imported from the outside (such as the case here). The DATASET has the ability to read a CITIfile through appropriate menu selections in the respective tool. Once a CITIfile has been read into the DATASET, load-pull data is linked into the EDA environment and measurements may be viewed by ADS data display. However, one more step is required to link the data to the simulator. In the schematic environment, a special component called the DataAccessComponent (DAC) must be instantiated on the schematic to permit the simulator to process the data. The DAC (or DATASETVARIABLE in MDS) points to the file containing the measured data, makes the dependent and independent variables accessible to the simulator, and can support up to ten independent variables. In essence, the DAC imple-

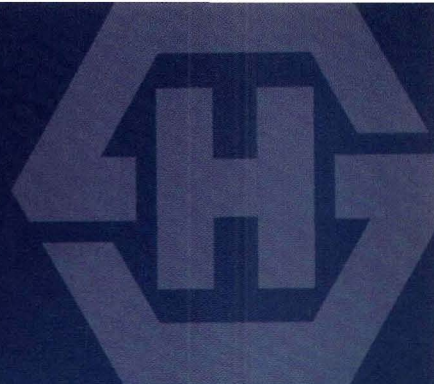
ments Eq. 5 in the simulation. The DAC is more than just a lookup table; it has the ability to interpolate between independent variables. Interpolation enables optimizations providing continuity to the dependent data. Details on optimization will be covered later.

ADS has the capability to graphically display load-pull data directly from the measurement system without passing through the simulator. Many different graphical cross-sections can be displayed since Eq. 5 is a six-dimensional relationship. Several data display graphics will be presented as examples of analyzing the measurements. The examples shown here are based on a Motorola MRF9045M LDMOS device operating at its rated 45-W out-

Agilent EDA tools support the concept of a DATASET object. This object holds either simulation information or data imported from the outside.

put-power level in the 700-to-1000-MHz range.

Power out and efficiency versus load are shown in Figs. 4a and 4b. Performance variations are plotted against two independent variables represented by the equivalent parallel $R_p C_p$ presented to the device output. The capacitance sweep (C_p) is shown on the x-axis while the multiple traces show variations in parallel resistance (R_p). Essentially, the plots depict Eq. 5 with R_p and C_p set as the swept ordinates (wildcards) and the other four variables fixed. Figure 4 shows, for example, that the peak power occurs at approximately 45 pF and 8.5 Ω . Efficiency peaks at a slightly larger capacitance, approximately 50 pF. If other frequencies were plotted in this format, it would be seen that the peaks remain relatively constant at these capacitance values for the respective parameters, lending credibility to



click

and run !
With HUBER+SUHNER
QMA Connectors

- Similar performance to SMA with easier and quicker installation
- 10 times faster to mate than SMA
- No tooling or torquing required
- Ergonomically optimized coupled with secure mounting
- Higher packing density
- 360 degrees of axial rotation



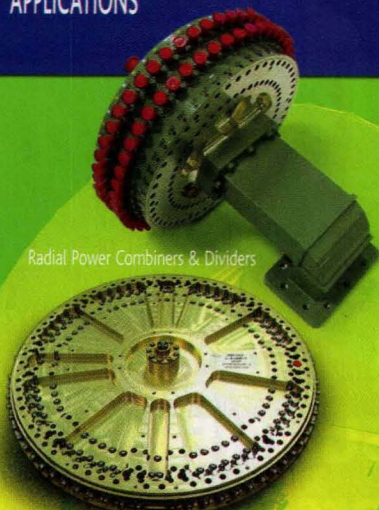
HUBER+SUHNER

HUBER+SUHNER AG
Mobile Communications+Electronics
9100 Herisau, Switzerland
Phone +41 (0)71 353 41 11
Fax +41 (0)71 353 45 90
www.hubersuhner.com

USA and Canada:
Toll free 1 866 HUBER SUHNER
(1-866-482-3778)
Fax 1-847-397-2882
www.hubersuhnerinc.com

HUBER+SUHNER – Excellence in Connectivity Solutions

PASSIVE COMPONENTS, ASSEMBLIES & SCREENING SERVICES FOR HI-REL & SPACE APPLICATIONS



Radial Power Combiners & Dividers

Combiner/Divider Features & Options:

- Designed for High Power Levels (Up to 30 KW output)
- Frequency ranges from UHF to 30 GHz
- Space & Hi-Rel Military Qualified
- Integrated phase matched isolators

Model No.	Type	Input & Output VSWR	Insertion Loss (dB)	RMS Amplitude Variation (+/- dB)	Absolute Amplitude Variation (+/- dB)	RMS Phase Variation (+/- deg)	Absolute Phase Variation (+/- deg)
CWC081-XXX*	8:1	1.4:1	0.30	0.25	0.50	1.5	3
CWC161-XXX*	16:1	1.4:1	0.30	0.25	0.50	1.5	3
CWC241-XXX*	21:1	1.4:1	0.30	0.25	0.85	2.0	3
CWC321-XXX*	32:1	1.4:1	0.50	0.30	0.85	2.0	4
CWC361-XXX*	36:1	1.4:1	0.50	0.30	0.95	2.0	4
CWC481-XXX*	48:1	1.4:1	0.60	0.40	0.95	4.0	5
CWC501-XXX*	50:1	1.4:1	0.60	0.40	0.95	4.0	5
CWC641-XXX*	64:1	1.4:1	0.60	0.50	1.20	5.0	8
CWC681-XXX*	68:1	1.4:1	0.60	0.50	1.20	5.0	8

*PIN to be completed after receipt of actual FREQ range

**For Divider substitute the letter "D" in place of the 2nd letter "C"

Other Products Include:

- Filters (Space/Hi-Rel)
- Multiplexers and Couplers
- OMT/Polarizers
- Environmental Screening & Qualification Services



Ciao Wireless, Inc.

4000 Via Pescador • Camarillo, CA 93012
Tel (805) 389-3224 • Fax (805) 389-3629
E-mail Sales@CiaoWireless.com
CiaoWireless.com

DESIGN

the $R_p C_p$ sweep method. Linearity and gain can be plotted similarly while complex device input Γ can be displayed on the Smith Chart. Concurrently generating these plots enables viewing all pertinent performance metrics versus load. Plots versus the other independent variables can also be displayed by fixing the load wildcards and enabling the sweep of other terminal variables. For example, drive-up performance or frequency dependencies can easily be viewed by making them the wildcard variable in the graph. A further enhancement is to add "slider controls" to the other variables to vary the values in those dimensions. **Figure 5** shows that contours can be displayed using the ADS built-in polar contour function. **Figure 6** illustrates a three-dimensional (3D) power-out versus load plot where the data have been imported into a mathematical analysis package (the HiQ™ package from National Instruments). Visualization may be accomplished by sweeping a third independent variable (such as power-in) to create an animation. Clearly, the simulation tool and other

mathematical packages enable the designer to present and analyze the raw measured data equivalent or superior to the commercial measurement systems. Data presentation, however, is just an initial step in using the measurements for designing PAs.

Linking measurements to a circuit simulator creates powerful design opportunities. By employing a simulator, the data can be further reduced to insightful information and utilized for PA circuit design. One analysis approach is to employ an optimizer to search for specific performance conditions. For example, suppose it is desired to find the impedance locus that conform to concurrent power-out, efficiency, and linearity goals versus frequency. An optimization can be established to perform this task using the circuit simulator. **Figure 7** is a schematic excerpt showing

how three variable equations (output power, third-order intercept, and efficiency) and goal statements are established in ADS. Variable expressions are linked to the goal control blocks as well as the DAC, which provides association to the measured data. During each iteration, the DAC reads and interpolates the performance values based on the present independent variable values. In this case, R_p and C_p independent variables (representing the load) are allowed to vary in the optimization (for simplicity, assume the other independent variables are fixed). When properly configured, the goals, equations and DAC will establish an error function. Since the DAC can interpolate the dependent variables, the equations


behave as continuous functions. The optimizer therefore drives the R_p and C_p values continuously until an error function minimum is achieved.

The complexity of the example can be expanded by allowing the other independent variables to vary in the optimization (and allowed to take on different values at different frequencies). These

other independent variables can also be plotted versus frequency.

Figure 8 shows the impedance locus presented to the output required to meet the three performance criteria based on an optimization. In this optimization, the drive-power and bias current were also allowed to vary; however the supply voltage was held constant. These other independent parameters also can be plotted along with the high-level responses after optimization. This optimization could be further tailored to weight each different performance goal differently or attach more importance to specific parts of the band. A further embellishment is to parameter sweep the goal specifications resulting in a family of gamma plots. The analysis described here might be one of the first steps a user would perform in the EDA simulation environment to understand the target

Linking measurements to a circuit simulator creates powerful design opportunities.



Thursday: 3:20 pm
Winsurfing off the coast

We know you have better things to do...

The RFMD® Advantage

High-performing, reliable, low-cost solutions

Broad technology base

Industry-leading capacity

Design expertise

Knowledgeable sales team

Application and design support

On-time delivery

Our communication solutions will give you a whole new perspective.

RF 
MICRO-DEVICES

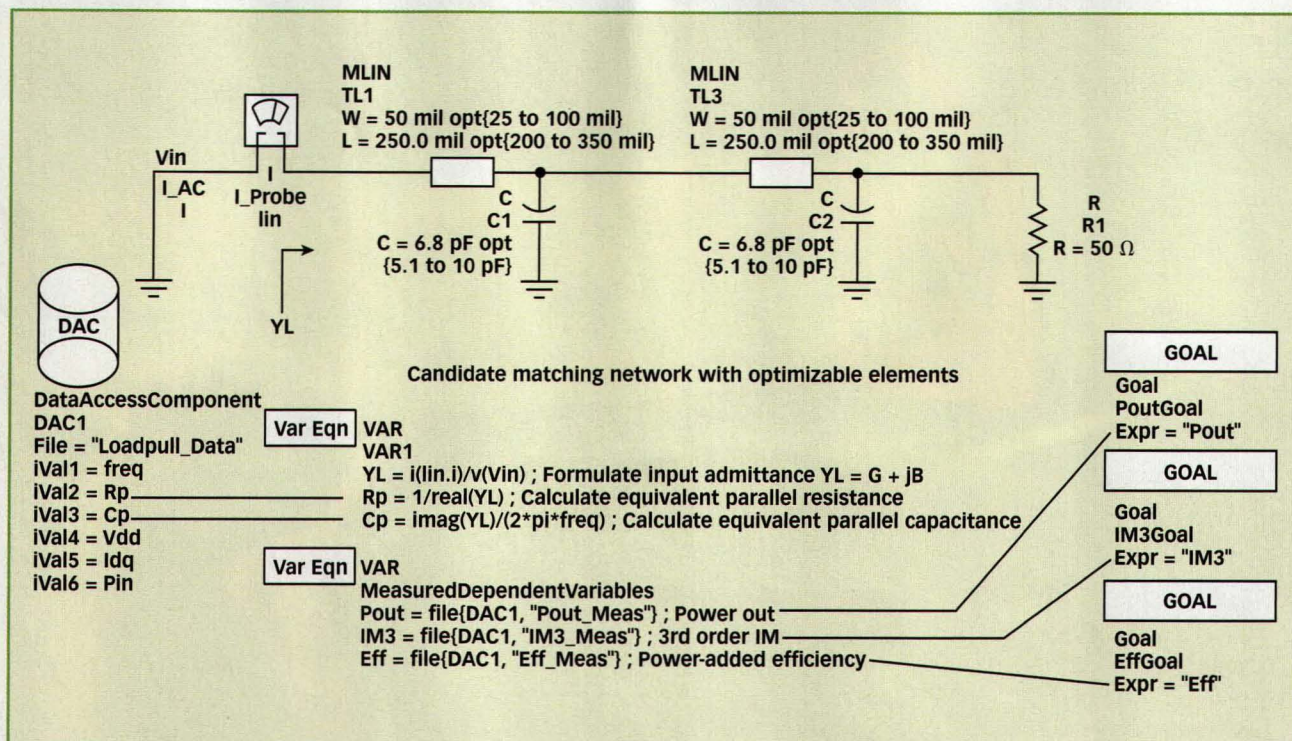
Providing Communication Solutions™

RF Radio Wireless LAN Bluetooth™ Infrastructure Wireless Handsets CATV PCS Systems

www.rfmd.com

ISO 9001: 2000 Certified
ISO 14001: 1996 Certified

RF MICRO DEVICES®, RFMD®, Optimum Technology Matching® and Providing Communication Solutions™ are trademarks of RFMD, LLC. BLUETOOTH is a trademark owned by Bluetooth SIG, Inc., U.S.A. and licensed for use by RF Micro Devices, Inc. © 2003 RF Micro Devices, Inc.



9. This ADS schematic excerpt illustrates a generic matching network optimization setup.

impedances the output matching network must achieve. The next step would be to design and optimize an output network using this response as a target.

Previous analysis provided the output load to achieve the specified performance goals. A network must be designed that closely mimics this response. In the traditional disconnected process, the impedance locus would be the only data the designer has available within the simulation environment—providing he was skilled enough to have hand selected the best points from contours or tabular data. With the system described here, however, the full load-pull space including impedance with corresponding performance is available. Using Fig. 8 as a guide, an initial topology and component values are chosen usually through the Smith Chart or matching synthesis program. Once the topology and values are established, a circuit optimization is conducted with the element values driven by performance specifications, not abstract impedances. Contrast this new method with the traditional approach where only a handful of select states are available. With prior methods, EDA optimization goals are strictly impedance

based where the designer attempts to optimize for the best match. No insight is provided on high-level performance—a problem when the optimized response is not identical to the selected values. The new method with the multidimensional load-pull space integrated in the EDA simulator takes a different

High-level performance metrics and their corresponding impedances are accessible to the simulator and enable the designer to establish network optimization using these high-level specifications as goal drivers.

approach to optimization.

High-level performance metrics and their corresponding impedances are accessible to the simulator and enable the designer to establish network optimization using these high-level speci-

fications as goal drivers. As illustrated in Fig. 9, this is accomplished by driving the candidate output matching network with an AC source and utilizing voltage and current probes formulating an admittance calculation looking into the candidate network. Through the auxiliary equations, the driving-point admittance is converted to equivalent $R_p C_p$. Values of R_p and C_p are then linked into the DAC element; steering the value of the high-level performance metrics. The optimization process is iterative and an error function based on the goal blocks is calculated after each iteration and drive tunable circuit element values. Circuit-element changes affect driving point admittance and close the optimization loop. At the conclusion of the optimization, an impedance response, performance responses, and optimized circuit-element values are available. Network optimization is based on high-level performance goals. Furthermore, the optimization used the full space of load-pull data to arrive at a solution—not a group of heuristically selected points. The results of a sample optimization are shown in Fig. 10.

The amplifier design may proceed



802.11a 802.11g
802.11b 802.11a/b/g

highly integrated

small size
solution

low power

cost effective

high performance

...than to worry about your next WLAN solution.

Introducing our complete WLAN solutions for all 802.11 standards - designed to meet your customers' demands for high-speed wireless connectivity. From 2.4 GHz WLAN solutions to advanced 5 GHz and multi-mode two-chip CMOS solutions, our chipsets easily integrate into wireless clients as well as specialty modules in consumer electronic devices, access points and commercial/residential gateways. Our applied wireless networking knowledge and innovative technologies in RF CMOS, baseband/DSP, Media Access Control (MAC), protocol stack software and power amplifier design enable us to deliver highly optimized products for end-to-end wireless networks. In addition to our comprehensive WLAN product portfolio, RF Micro Devices provides extensive applications support as well as reference designs and support documentation.

Our complete WLAN solutions will give you more free time to play in the surf.



**Dual Band 802.11a/b/g
(2.4GHz and 5GHz)**

- **RFCS5420** 2-chip complete chipset solution
- **RF5425** single chip dual-band 1.8V CMOS radio
- **RF5421** multi-protocol baseband/MAC IC
- **AccuChannel™** equalization for greater range
- Flexible MAC architecture
- On-chip high speed ARM922T with cache
- WEP, TKIP, 802.1x, AES support

**802.11a
(5GHz)**

- **RFCS5400** 2-chip complete chipset solution
- **RF5405** single chip 5GHz 1.8V CMOS radio
- **RF5401** integrated baseband/MAC IC
- **AccuChannel™** equalization for greater range
- Flexible MAC architecture
- On-chip high speed ARM922T with cache
- WEP, TKIP, 802.1x, AES support

**802.11b
(2.4GHz)**

- **RF2958** low-cost, high-performance single chip radio
- **RF5189** internally matched high-efficiency PA
- **RF3002** small size, enhanced performance baseband
- Minimal external components
- Low power and small size for embedded applications

**802.11g
(2.4GHz)**

- Single-chip radio
- Power amplifier

For sales or technical support, contact RF Micro Devices at
336.678.5570 or callcenter@rfmd.com.

RF 
MICRO-DEVICES

Providing Communication Solutions™

CDMA CDMA2000 EDGE GPRS GSM IEEE 802.11 TDMA UMTS WCDMA

www.rfmd.com

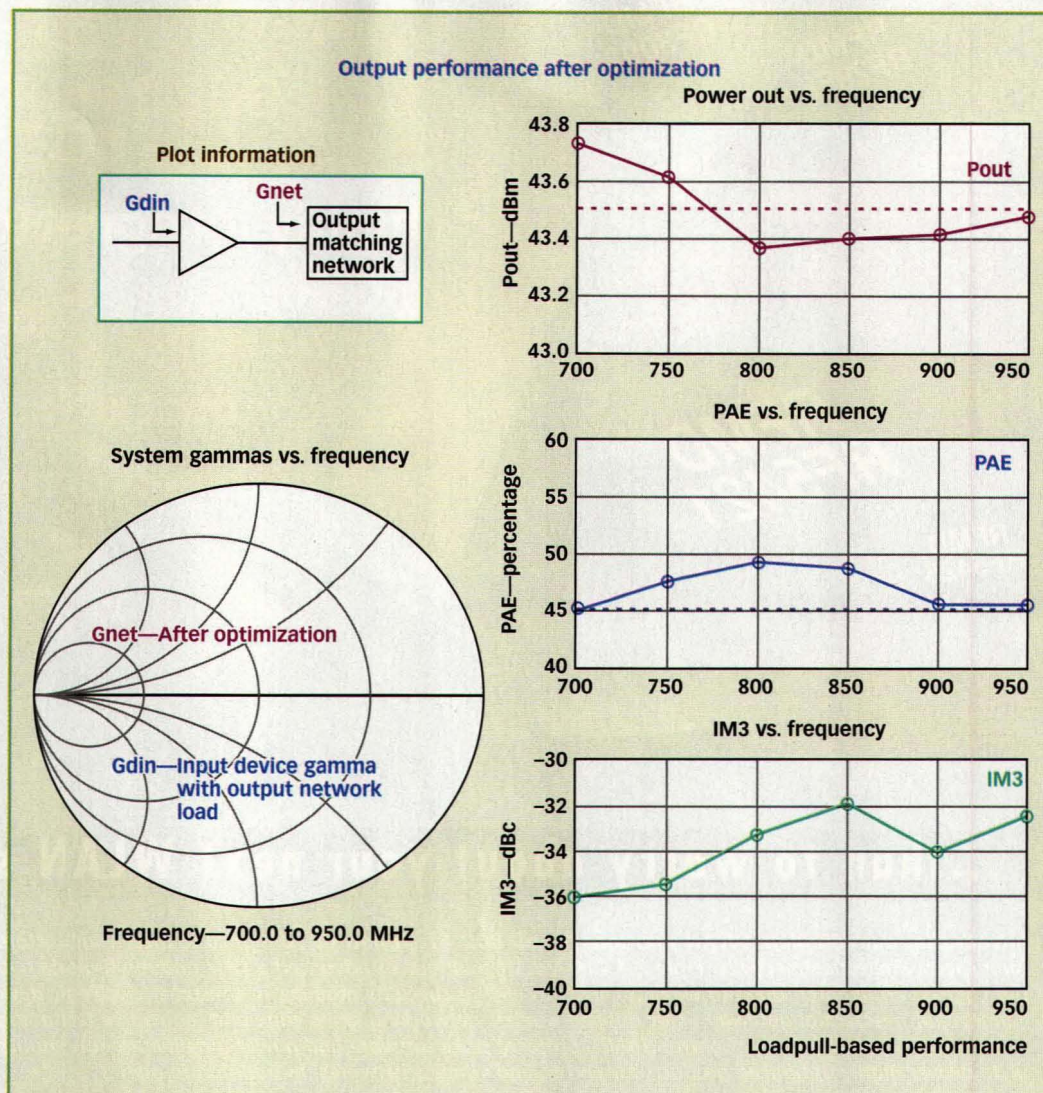
along a number of avenues at this point. A statistical Monte Carlo run can be established by allowing the circuit elements to vary and observing histograms of high-level performance. The input match can be designed using similar optimization techniques since the device input impedance is a dependent load-pull variable. Once the I/O matches are designed, a module drive-up performance is possible referencing the load-pull data. Integrating the load-pull measurements into the EDA simulation environment clearly opens up new, cycle-time-saving simulation possibilities.

The RF power designer now has a more comprehensive toolbox at his disposal. Linkage of a load-pull database to a circuit simulator effectively creates a behavioral model. The model can be instantiated into the EDA environment just like any other primitive model and enables rapid up-front architectural decisions leading to circuit and module designs. The EDA utilities discussed here are just a few of the design steps in the development process flow. Small signal s-parameters over multiple bias conditions can be added to the library database. With these large and small signal data, the entire PA design flow can be implemented into a "Design Guide." The design guide concept is a series of development steps required to design a specific application (i.e., a PA). When an ADS customized design guide is created, these steps become sequential pull-down menu selections integrated into the design environ-

ment. This promotes design consistency and eliminates much of the tedium in setting up, formatting, and presenting simulation information. It also provides a consistent interface that can be easily archived and navigated for reuse opportunities. **IMRF**

REFERENCES

1. "What's New in 2002?" Applied Wave Research, El Segundo, CA, www.mwoffice.com.
2. "Advanced Design System 2002 Circuit Component Systems Models," Agilent Technologies Manual Set, February 2002, p. 296, www.agilent.com.
3. "Precision Microwave Instruments and Components Catalog," Maury Microwave Corp., Ontario, CA, 2001, p. 64, www.maurymw.com.
4. "The CCMT- μ W-PADS Work Station," Technical Note 1-93, Focus Microwaves, Inc., Dollard-des-Ormeaux, Quebec, Canada, www.focus-microwaves.com.
5. "WinPADS, A Power Amplifier Design Software Using Load-Pull Contours," Product Note 56, Focus Microwaves, Inc., Dollard-des-Ormeaux, Quebec, Canada, www.focus-microwaves.com.



10. These performance levels result following the output-network circuit optimization for the Motorola MRF9045M power transistor.

PDD

Your
Online
Resource

For RF and Microwave
Products and Manufacturers

If you need a part, you'll find it at:

www.m-rf.com

HAVING TROUBLE WITH YOUR RADIO DESIGN?

Let Maxim's RF Expertise and Products Work for You



Using in-house **SiGe BiCMOS** process technology, Maxim's world class wireless engineers have developed the broadest family of low-power, low-cost, high-performance, complete system solution **RF ICs** and **ASIC** capabilities for tomorrow's **wireless designs**.

Whether your WLAN product needs more range, your CATV design requires DQPSK compatibility, your 3G cellular phone begs for a space-saving receiver chipset or PA, or you want to design your own circuit using our SiGe process technology, Maxim has a solution just for you.

Visit **Maxim's** website to find the RF solutions not found anywhere else.

maxim-ic.com/radio

Your Wireless Solution Experts

- ◆ Reference Design Notes
- ◆ Application Notes
- ◆ Complete Solutions Pages
- ◆ Parametric Search for Wireless ICs
- ◆ RF Discussion Group
- ◆ Free Samples Ordering

MAXIM

MAXIM/DALLAS
DIRECT!
DISTRIBUTION

1-888-MAXIM-IC

ARROW

ARROW ELECTRONICS, INC.
1-800-777-2776

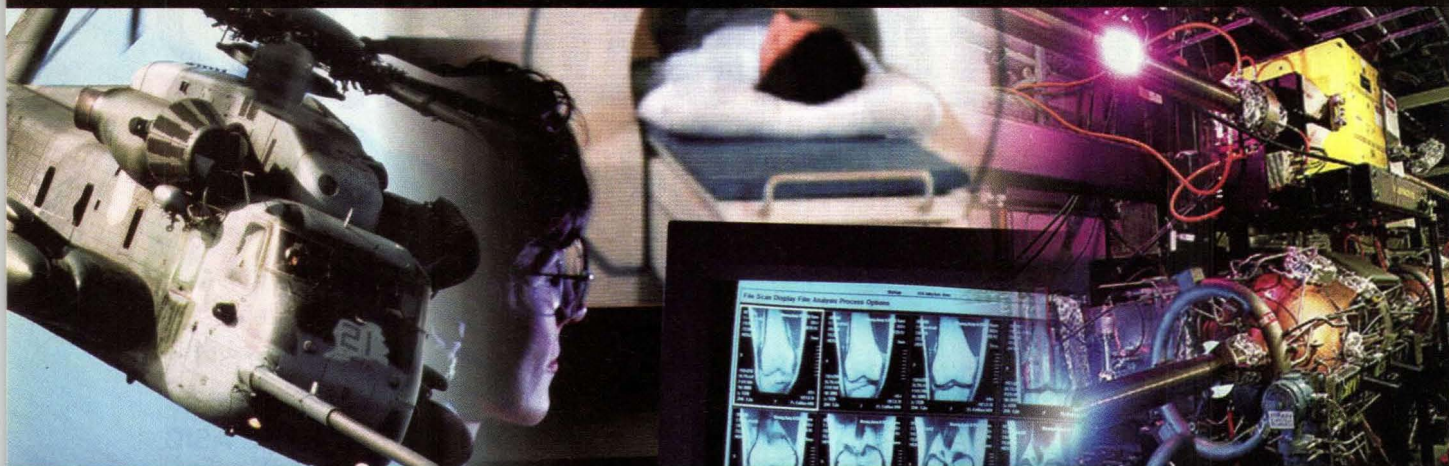
AVNET
SILICON

1-800-332-8638

Distributed by Maxim/Dallas Direct!, Arrow, Avnet Electronics Marketing, Digi-Key, and Newark.

MAXIM is a registered trademark of Maxim Integrated Products, Inc. © 2003 Maxim Integrated Products.

VISION=VALUE



Specialized Design...Within Weeks Not Years!

ARKalmus' new Vision Concept saves you a lot of time and money by letting you specify an amplifier within a defined frequency range from 5 basic modules offered:

- Choose the Power and Frequency You Need From the 5 Basic Modules Offered — Each Covers a Portion of the 0.3 MHz - 4.2 GHz, 6 - 500 Watts Range
- Quick Turnaround Time Without the Usual High Cost
- Allows a "Proof of Principle" Test Quickly and Accurately
- Unique Power Supply Makes It Easy
- Mix and Match Components

- Build Any or All of Your System: Control Modules, Wiring Harnesses, Switching Modules, Couplers, Combiners/Splitters

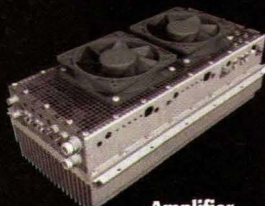
- Complete Documentation is Supplied

Your Specs...Our Components...To Build an Amplifier That Meets Your Unique Requirements Quickly.

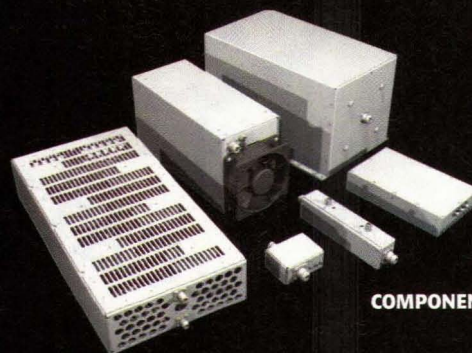
To find out more about the ARKalmus Vision Concept, call us at 425.485.9000 to request a brochure or download one at www.arkalmus.com



Amplifier
Module



Amplifier
Module



COMPONENTS



KALMUS

Reducing ESR Measurement Errors

A variety of different measurement techniques can be used to evaluate the equivalent series resistance (ESR) of high-frequency capacitors and inductors, with varying results.

Capacitor and inductor improvements have resulted in lower equivalent-series-resistance (ESR) values for these circuit elements. In turn, measurements of ESR for capacitors and inductors have become even more difficult. ESR measurements errors are caused either by the minimum (or absolute value) of the ESR or the phase of the complex signal vector, both of which can present very significant

measurement challenges. Resonant techniques or the auto-balancing bridge are used for low-frequency measurements,

while the resonant method using a cavity, a reflection test set with a vector network analyzer (VNA) or the RF current-voltage (I-V) method with dedicated impedance measuring equipment are used for high-frequency measurements.

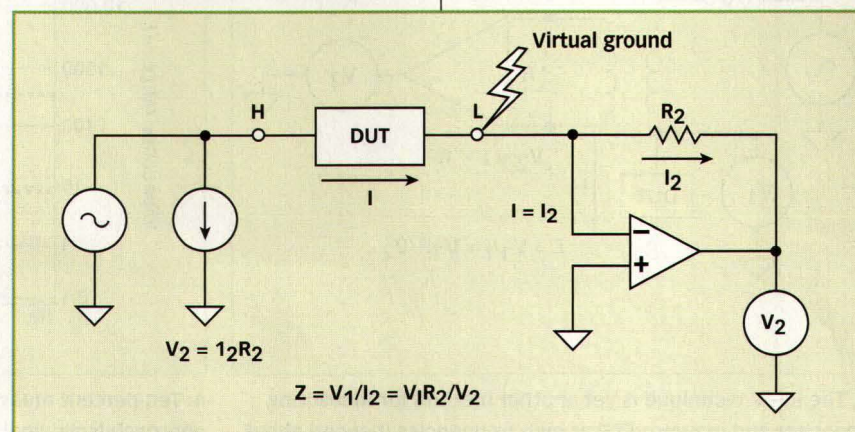
For low-frequency measurements, the autobalancing bridge measurement technique (Fig. 1) includes an AC source to supply current through a device under test (DUT). The voltage across the DUT is measured by V1 and the current

while the resonant method using a cavity, a reflection test set with a vector network analyzer (VNA) or the RF current-voltage (I-V) method with dedicated impedance measuring equipment are used for high-frequency measurements.

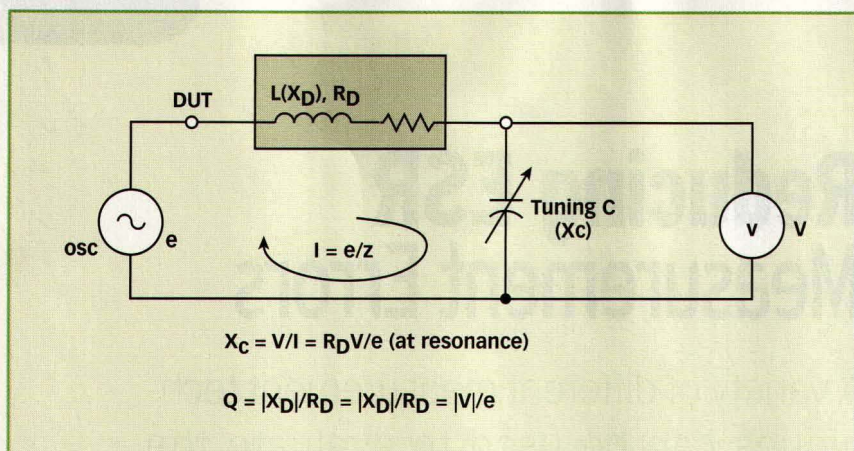
For low-frequency measurements, the autobalancing bridge measurement technique (Fig. 1) includes an AC source to supply current through a device under test (DUT). The voltage across the DUT is measured by V1 and the current

GREGORY L. AMORESE Senior Engineer

Agilent Technologies, Inc., 1400 Fountaingrove Pkwy., Santa Rosa, CA 95403; (707) 577-2000, e-mail: greg_amorese@agilent.com, Internet: www.agilent.com.



1. This diagram illustrates the autobalancing bridge-measurement technique.



2. This simple diagram shows the resonant measurement technique for evaluating capacitor and inductor ESR.

through the DUT is derived from V_2/R_2 . It is important to remember that V_1 and V_2 are vector voltmeters, which means that they measure both the magnitude and phase of the AC signal. To achieve this, they actually measure the magnitude of the signal at 0 deg. (representing the real part) and the magnitude of the signal at 90 deg. (for the imaginary part). These measurements are made using mixers with very high dynamic ranges.

Although the real part will represent the ESR value of the DUT, most low-ESR components also have a relatively high reactive part. The ratio of the two is called the quality factor, Q (or inversely D or $\tan \delta$, and is the ratio of the imaginary to real parts. Since ceramic capacitors with Q over 10,000 are quite common, the mixer must attempt to

separate the real portion (ESR) in the presence of a very large input signal that is almost entirely reactive, which is a significant challenge.

Most impedance measurement techniques use some form of vector separation. This inherently limits the accuracy of very low ESR measurements. Recent advances have been made in mixer design and new instrumentation that allow measurements of even-lower ESR values to be measured by the autobalancing bridge technique.

However, another method called the resonant technique does not rely on vector separation, and has been used for many years in the form of the Q-meter (Fig. 2). Although this technique is cumbersome, it can provide the most accurate Q measurement results when the Q is very high (more than 10,000), as

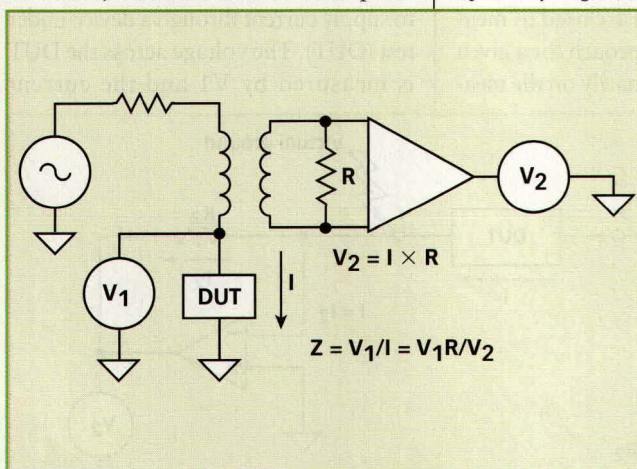
long as extreme care is taken in performing the measurement.

For high-frequency ESR measurements, Q-meters usually operate up to the tens of megahertz, and autobalancing bridge technology now allows measurements to 110 MHz. However, in many cases, ESR must be measured at higher frequencies where three techniques—the RF-IV technique with dedicated impedance measuring equipment, the resonant technique using a cavity, and the reflection test set with network analyzer—are available.

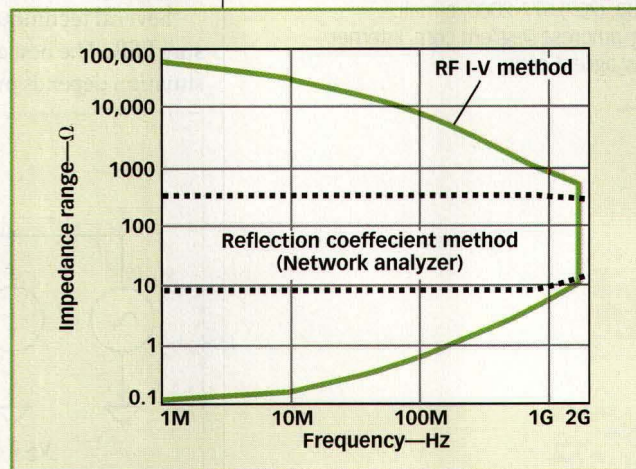
The RF-IV technique (Fig. 3) is very different from the autobalancing bridge approach, although it appears quite similar according to the simple schematic. Both methods require two vector voltmeters: one for current and one for voltage, each of which has the same basic operating principles and consequently the same limitations as when used in low-frequency ESR measurements. The technique that employs a VNA and reflection test set does not work well for very low or very high impedances and results in very large ESR measurement errors. Figure 4 offers a comparison of the RF-IV (solid-line) and VNA (dotted-line) methods.

Calibration Standards

All measurements will have error caused by the quality and traceability of the calibration standards as well as the pro-



3. The RF-IV technique is yet another method for measuring capacitor and inductor ESR at high frequencies (beyond about 100 MHz).



4. Ten-percent measurement accuracy range from the RF-IV approach (solid line) and the vector-network-analyzer method (dotted line) are compared here.



300MHz-6GHz LTCC MIXERS

\$3.95 **IN STOCK**
from ea. (Qty. 1000)

For Commercial, Military, and Industrial Use, Mini-Circuits proudly introduces MCA1, the world's first commercially available line of low temperature cofired ceramic (LTCC) frequency mixers! Highly reliable, extremely broad band, and very low in cost, these patent pending double balanced mixers have excellent electrical performance and are available in level 7, 10, and 13 (LO) models for your 300MHz to 6GHz designs. As for ruggedness and reliability, MCA1 mixers have all circuitry hermetically embedded inside the ceramic making them impervious to most environmental conditions. The process also gives you superior stability under temperature, high repeatability, and compact 0.065" profile. They're ideal for the COTS program, as well as your commercial and industrial applications. So contact Mini-Circuits now. Our team is ready to handle your needs worldwide with quick shipments, custom designs, high volume production capability, and fast turn-around.

Mini-Circuits...we're redefining what VALUE is all about!



Typical Specifications

Actual Size	Model	LO Level (dBm)	Freq. (MHz)	Conv. Loss (dB)	LO-RF Isol. (dB)	Price \$ ea. (Qty. 10)
	MCA1-24	7	300-2400	6.1	40	5.95
	MCA1-42	7	1000-4200	6.1	35	6.95
	MCA1-60	7	1600-6000	6.2	30	7.95
	MCA1-24LH	10	300-2400	6.5	40	6.45
	MCA1-42LH	10	1000-4200	6.0	38	7.45
	MCA1-60LH	10	1700-6000	6.3	30	8.45
	MCA1-24MH	13	300-2400	6.1	40	6.95
	MCA1-42MH	13	1000-4200	6.2	35	7.95
	MCA1-60MH	13	1600-6000	6.4	27	8.95

BLUE CELL™

Detailed Performance Data & Specs Online at: www.minicircuits.com/mixer2.html



P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



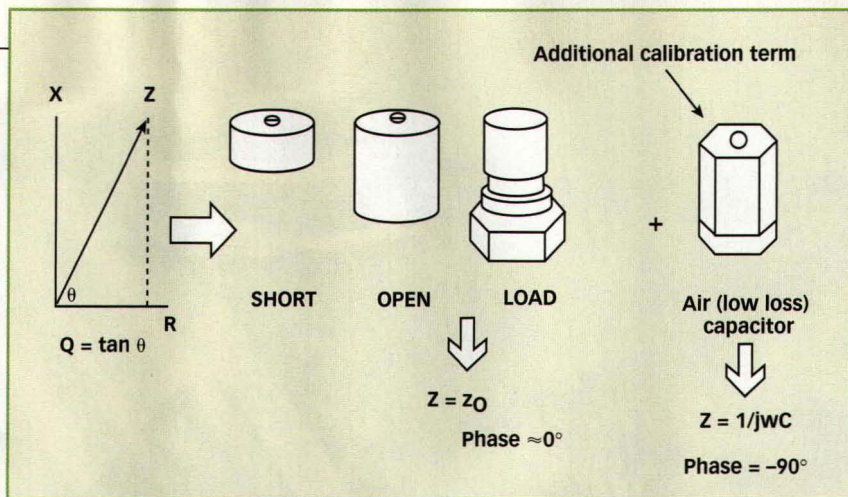
The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001 ISO 14001 CERTIFIED

385 Rev B

cess used for calibration. In the auto-balancing bridge technique, the process and stability of the instrument is very high, and calibration is performed at a calibration lab once a year.

High-frequency techniques require the user to establish the calibration plane with traceable standards or working standards (i.e., devices in which the user has a high degree of confidence). Since low-ESR devices typically have relatively high Q (although a rectangular metal block may have low ESR and low Q), most measurements are made on devices with low ESR and high Q . While high-frequency techniques also usually employ open/short/load calibration, using only these standards will result in significant ESR error because the phase of these standards is not well known. Because of this limitation, impedance analyzers and impedance-capacitance-resistance (LCR) meters using the RF-IV technique support an



5. Using an additional calibration device can improve high-frequency ESR measurement.

additional calibration standard called the low-loss capacitor. This additional calibration device provides a well-known phase reference to the calibration process, which produces much more accurate ESR measurements (Fig. 5).

A typical fixture model (Fig. 6) is used for both low-frequency and high-frequency measurement situations, but as frequency decreases, port extension

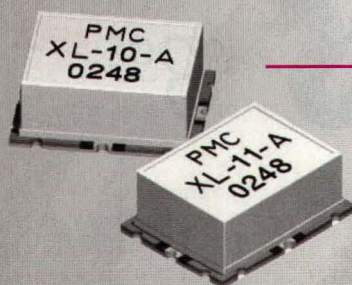
phase shift becomes insignificant. In general, a 1-m port extension can be ignored at frequencies below 100 kHz, and a 10-cm extension can be ignored below 1 MHz.

The first step is to remove the fixture errors, excluding the port extension (phase shift). The fixture model includes a series resistor and inductor and a shunting resistor and capacitor. The

PULSAR
MICROWAVE CORPORATION

products:

- 90° & 180° hybrids
- frequency doublers
- mixers
- power dividers
- directional couplers
- attenuators/switches
- i&q networks
- rf transformers
- bias tees



ultra-broadband mixers

The widest frequency coverage mixers to date have been introduced in the new XL-10 and XL-11 series. XL-10, with an LO/RF of 5-5000 MHz and an IF of 5-3000 MHz, has a conversion loss of 9.9 dB with LO/RF and LO/IF isolations of 25 and 20 dB, respectively. The XL-11, with an LO/RF of 1-6000 MHz and an IF of DC-700 MHz, has a conversion loss of 9.0 dB with LO/RF and LO/IF isolations of 20 and 12 dB, respectively. We also have a mixer in the series available with an LO/RF frequency up to 7000 MHz.

for a complete online catalog, visit:

www.pulsarmicrowave.com

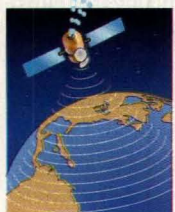
Pulsar Microwave Corporation • 48 Industrial West • Clifton, NJ 07012 • Tel: 800-752-3043 • Fax: 973-779-2727 • sales@pulsarmicrowave.com

ISO 9001
REGISTERED FIRM

THE GLOBAL SOLUTION... AND BEYOND!



10MHz to 7GHz AMPLIFIERS **\$99⁹⁵** from (1-9 qty.)



From amateur radio to cellular to satellite applications, with medium output power up to 17dBm, Mini-Circuits versatile ZJL and ZKL connectorized amplifiers offer the broad range of choices designers demand for achieving high system performance goals. Ultra-wideband models deliver **gain ranging from 9 to 40dB** and IP3 up to +32dBm. But beyond the performance and reliability built into these miniature 12V amplifiers lies another important feature, the low price...from only \$99.95! Call now for fast delivery.

Mini-Circuits...we're redefining what VALUE is all about!

SPECIFICATIONS

Model	Freq (MHz)	Gain (typ) Midband Flat (dB)	Gain (typ) Flat (dB)	Max. P _{out} ¹ (dBm)	Dynamic Range (Typ @2GHz ²) NF(dB) IP3(dBm)	Price \$ea. (1-9)
ZJL-5G	20-5000	9.0	±0.55	15.0	8.5 32.0	80 129.95
ZJL-7G	20-7000	10.0	±1.0	8.0	5.0 24.0	50 99.95
ZJL-4G	20-4000	12.4	±0.25	13.5	5.5 30.5	75 129.95
ZJL-6G	20-6000	13.0	±1.6	9.0	4.5 24.0	50 114.95
ZJL-4HG	20-4000	17.0	±1.5	15.0	4.5 30.5	75 129.95
ZJL-3G	20-3000	19.0	±2.2	8.0	3.8 22.0	45 114.95
ZKL-2R7	10-2700	24.0	±0.7	13.0	5.0 30.0	120 149.95
ZKL-2R5	10-2500	30.0	±1.5	15.0	5.0 31.0	120 149.95
ZKL-2	10-2000	33.5	±1.0	15.0	4.0 31.0	120 149.95
ZKL-1R5	10-1500	40.0	±1.2	15.0	3.0 31.0	115 149.95

NOTES:

1. Typical at 1dB compression.
2. ZKL dynamic range specified at 1GHz.
3. All units at 12V DC.



Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718)332-4661 **INTERNET** <http://www.minicircuits.com>

For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE • EEM • MICROWAVE PRODUCT DATA DIRECTORY • WWW.RFGLOBALNET.COM

ISO 9001 CERTIFIED

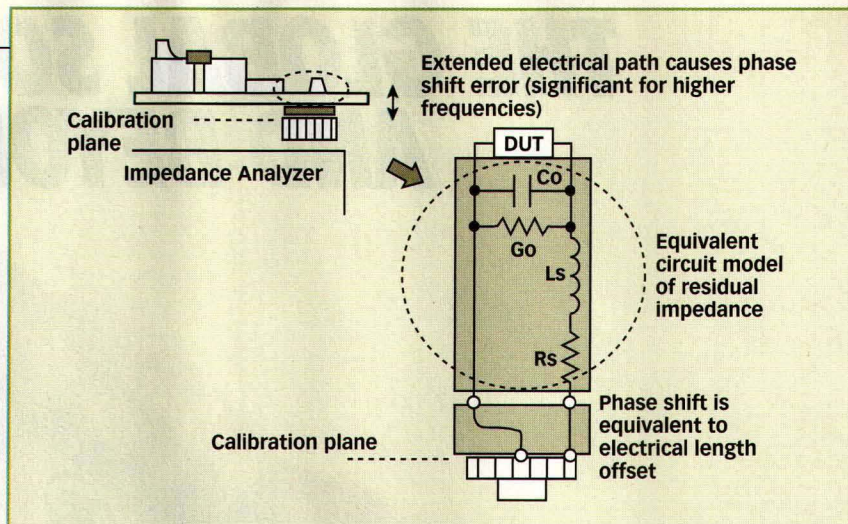
F 232 Rev D

open/short compensation process requires that if the value of each of the four elements can be determined and the combination of the DUT with these elements (i.e., the DUT in the fixture) can be measured, the actual value of the DUT can be determined by mathematically removing the effect of the elements. This is theoretically very straightforward but presents some challenges in practice.

To measure the shunting C (B) and R (G) values, open compensation is performed. This simply requires the component to be removed and the contacts to be left in the same position as they would be with the component inserted. The short compensation method is used to measure the series inductance and resistance values. In this case, the DUT measurement contacts must be shorted, which is difficult because while only the fixture's series R and L should be measured, the short will also have a series resistance and inductance. In low-frequency cases, it may be possible to move the contacts to perform a better short compensation, but in high-frequency cases moving the contacts will cause very large errors. Shorting block inductance is also extremely critical at higher frequencies.

A recent improvement has been made in modern impedance measuring equipment that allows the user to enter non-zero short values (for the L and R of the shorting block). This allows all subsequent measurements to be made properly without the need for additional calculations. If the user's measuring equipment does not have this feature, the data can be corrected on a personal computer.

The potential phase error inherent in the model of Fig. 6 (caused by a significant port extension) can be corrected depending on the type of extension, type of measuring equipment, and measurement frequency. Phase shift even causes errors at relatively low frequencies. ESR measurement data has been taken on both a low-frequency impedance analyzer and an RF impedance analyzer. Measurements were made of a 0.01- μ F ceramic capacitor on a model 4294A



6. This test fixture model is typically used for both low-frequency and high-frequency measurements.

impedance analyzer from Agilent Technologies (Santa Rosa, CA) with and without a 30-cm port extension. At 1 MHz, the correct ESR value was 390 m Ω , and with the 30-cm port extension it showed 360 m Ω (about 10-percent error). At 10 MHz, the error increased to about 30 percent. An RF impedance analyzer was used to measure the same device, and in this case, the incorrect measurements were performed with about 1 cm of uncorrected port extension.

Another consideration that must be made is how the port extension is to be performed. In the high-frequency case, the complete measuring environment is a single coaxial cable, so any port extension performed after the calibration plane should have minimal loss. Either a delay can be added to the analyzer (typically determined by applying a short and adding the proper delay to return to zero on the Smith chart), or by using a working standard calibration.

In the low-frequency case, other options may exist if using a four-terminal measuring instrument. All of Agilent's autobalancing bridges use the four-terminal pair (4TP) technique that provides superior ESR measurements at higher frequencies. Standard four-wire or five-wire techniques still have mutual coupling (transformer effect) that cannot be eliminated by electrostatic shields. The 4TP system actively drives equal but opposite current in the shield conductors compared to the current flowing in the center conductors. This eliminates the mutual coupling effect that is critical when making low-impedance mea-

surements like ESR.

When making 4TP port extensions, consideration must be given to the degree of coupling and to the measurement frequency. For large devices such as aluminum-can electrolytic capacitors, an attempt should be made to reduce the coupling affect by bringing the current source and voltage sensing leads together at the DUT at right angles to each other.

Fixture contacts play a very important role in the measurement of ESR. All of the discussions of ESR measurement accuracy are related to a perfectly-contacted DUT. In the case of a 4TP system, there are two contacting options. When measuring low-value capacitors (e.g., 10 pF), the total D (ESR) error will be greater with a four-wire contact than with a two-wire contact. Until recently, the four-wire option was used either for very large DUTs measured at low frequencies (usually with alligator clips) or required custom fixtures. The model 16044A fixture from Agilent Technologies brought four-wire contact to SMD devices for the first time. The low ESR values of many of today's capacitors and inductors require that attention be paid to correcting the many sources of error. Fortunately, by understanding the limitations of measurement technique, frequency dependencies, and techniques for fixture-error correction, excellent measurement results can still be obtained. **MRF**

FOR FURTHER READING

The Effect of Fixturing on ESR Measurements; CARTS Proceedings, 2001.

Bipolar Amplifiers

Standard Options:

- **Connector Options:**
SMA, BNC, Type N
- **Integrated Limiters**
- **Input Bias Tee for**
Fiber Optic
Photodetectors



OPERATING FREQUENCY (MHz)	MODEL NUMBER	GAIN (dB, Min.)	GAIN FLATNESS (\pm dB, Max.)	VSWR IN/OUT	NOISE FIGURE NF ₁ NF ₀ NF ₂ (dB, Max.)			OUTPUT POWER (dBm, Min.)
0.001 - 500	AU-1534	30	0.5	2.0:1	1.3	1.4	1.5	+8
0.01 - 200	AU-1442	35	0.5	2.0:1	1.2	1.2	1.2	+5
0.01 - 200	AU-1447	56	0.5	2.0:1	1.2	1.2	1.2	+12
0.01 - 250	AU-1559	11	0.5	2.0:1	4.2	4.2	4.2	+16
0.01 - 400	AU-1565	54	0.75	2.0:1	1.2	1.2	1.3	+14
0.01 - 500	AU-1310	30	0.5	2.0:1	1.3	1.4	1.5	+8
0.01 - 1000	AU-1402	18	1.0	2.0:1	6.0	5.0	5.0	+16
0.01 - 1000	AM-1300	27	0.75	2.0:1	1.4	1.6	1.8	+8
0.01 - 1000	AM-1431	35	0.75	2.0:1	1.4	1.6	1.8	+8
0.1 - 2000	AM-1364	9	1.5	2.0:1	6.0	6.0	6.0	+10
1 - 200	AU-1464	35	0.5	2.0:1	1.2	1.2	1.2	+6
1 - 400	AU-1421	24	0.5	2.0:1	2.4	2.4	3.1	+17
1 - 500	AU-2A-0150	30	0.5	2.0:1	1.3	1.4	1.5	+8
1 - 500	AU-3A-0150	44	0.5	2.0:1	1.3	1.4	1.5	+10
1 - 500	AU-4A-0150	60	0.75	2.0:1	1.3	1.4	1.5	+10
1 - 1000	AM-2A-000110	26	0.75	2.0:1	1.4	1.6	1.8	+6
1 - 1000	AM-3A-000110	35	0.75	2.0:1	1.4	1.6	1.8	+8
5 - 200	AUP-1568	26	0.75	2.0:1	5.0	4.5	4.5	+28
5 - 300	AUP-1495	11	0.75	2.0:1	15	9.0	9.0	+28
5 - 300	AUP-1496	23	0.75	2.0:1	8.0	7.0	7.0	+28
5 - 300	AU-1021	24	0.5	2.0:1	2.7	2.8	2.9	+20
5 - 300	AUP-1479	36	1.0	2.0:1	2.5	2.7	2.9	+28
5 - 1000	AM-1475	36	0.75	2.0:1	1.4	1.6	1.8	+15
5 - 2000	AM-1573	18	1.5	2.0:1	4.0	4.0	4.0	+21
5 - 2000	AM-1590	36	2.5	2.0:1	3.8	3.8	3.8	+20
5 - 2000	AM-1591	48	2.5	2.0:1	3.8	3.8	3.8	+20
100 - 1000	AM-1412	35	0.75	2.0:1	1.4	1.6	1.8	+14
100 - 2500	AM-1585	26	2.0	2.0:1	3.6	3.6	3.6	+20
200 - 2000	AM-1569	20	1.5	2.2:1	4.2	4.3	4.6	+14
1000 - 2000	AM-1477	37	1.0	2.0:1	1.8	2.1	2.4	+15



Quick Delivery!

From Stock to 2 weeks!

For additional information, please contact Bill Pope at
(631) 439-9115 or e-mail wpope@miteq.com



100 Davids Drive, Hauppauge, NY 11788
TEL: (631) 436-7400 • FAX: (631) 436-7430

www.miteq.com

Selecting RF chip capacitors for wireless applications

CHIP CAPACITORS ARE LIKE the electronic glue that holds together the most complex wireless circuits. Capacitors store the energy needed for the advanced operations of cellular telephones, Personal Digital Assistants (PDAs), wireless local-area networks (WLANs), and other popular wireless tools. Designers who would like to brush up on their capacitor fundamentals will find some useful information on ceramic and porcelain chip capacitors in the application note, "Selecting RF Chip Capacitors for Wireless Applications," from American Technical Ceramics (Huntington Station, NY).

As the note explains, the most commonly used design categories for the company's capacitors are multilayer capacitors (MLCs) and single-layer capacitors (SLCs). Both types feature high dielectric strengths, optimized electrode patterns, high quality factor (Q), very high stability, and low dissipative losses.

The two-page note details the key performance parameters for comparing capacitors, including effective series resistance (ESR), quality factor (Q), and dissipation factor. The ESR is one of the most essential factors to consider in

the design of an RF circuit, since the ESR provides of measure of evaluating the dielectric and metal losses of a capacitor, as well as the manufacturing quality of the device.

Quality factor is a figure of merit that is a measure of a capacitor's ability to store energy in its dielectric material. As a correlation, a capacitor with a low ESR will yield a high Q value. As with the ESR, the Q must be calculated and evaluated at the design frequency of interest.

The dissipation factor (DF), which is also known as the loss tangent, is the reciprocal of Q. It is a measure of how much of the total reactive power presented to a chip capacitor is lost as heat. The dissipation factor is usually expressed as a number, such as 0.05, or as a percentage, such as 5 percent, of the amount of energy lost in a capacitor as heat. Copies of the application note are available free of charge from the company's website.

American Technical Ceramics, One Norden Lane, Huntington Station, NY 11746-2142; (631) 622-4700, FAX: (631) 622-4748, e-mail: Sales@atceramics.com, Internet: www.atceramics.com.

The dissipation factor is a measure of how much of the total reactive power presented to a chip capacitor is lost as heat.

Learn three techniques for measuring short-term stability

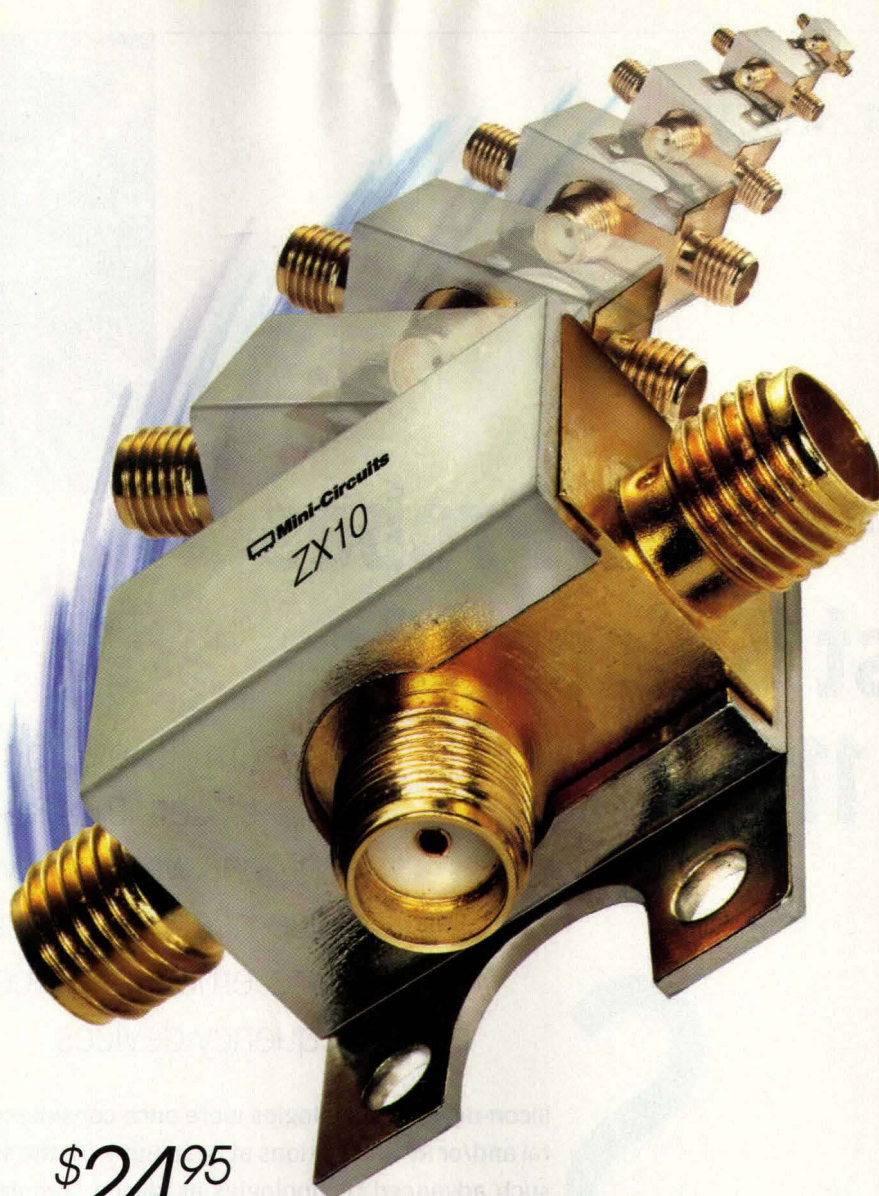
MEASURING THE SHORT-TERM frequency stability of a microwave source can be a challenge. Inadequate short-term source frequency stability can be the cause of poor performance and bit errors in microwave systems, so it is important for high-frequency designers to fully understand how to evaluate and analyze the short-term stability of a microwave source. Fortunately, a detailed, 15-page application note from Communication Techniques, Inc. (Whippany, NJ), "Three Techniques for Measuring and Interpreting Short-Term Frequency Stability," offers a solid review of modulation theory along with three approaches to the practical measurement of short-term frequency stability.

The note, which provides chapters on the measurement of residual frequency-modulation (FM) noise, the measurement of phase noise, and how to evaluate phase jitter as a noise parameter, opens with a review of modulation theory in order to establish quantitative relationships between the output spectrum of a signal source and its short-term stability. This

review introduces the concept of power spectral density and how it can be applied to the analysis of FM noise and short-term noise in high-frequency oscillators.

The note explains how to convert the power spectral density characteristics of source to the root-mean-square (RMS) signal (voltage or current) level, and then to an equivalent per Hertz value for analysis. The note offers a test setup for making residual FM measurements, as well as three test setups (reference/heterodyne, correlation, and anti-correlation approaches) for making phase-noise measurements on phase-locked sources. A section on calibration techniques includes a way to check the performance of the phase or frequency discriminator used in the phase-noise measurements, with the help of a signal generator and spectrum analyzer. Copies of the note are available free of charge from the company's website.

Communication Techniques, Inc., 9 Whippany Rd., Whippany, NJ 07981; (973) 884-2580, FAX: (973) 887-6245, Internet: www.cti-inc.com.



\$24⁹⁵
from **\$4** each

POWER SPLITTERS

2Way-0° 2MHz to 12.6GHz



SERIES

A new breed of SMA power splitters are small in size, small in price, and big on features. They're ZX10 power splitters from Mini-Circuits! These splitters have extremely wide bandwidths so you can cover all of your applications with only a few units. Each easily mountable model is less than 3/4" in size, so you conserve real estate in laboratory, production, and system environments. And thanks to exclusive patent pending unibody construction, ZX10 splitters are rugged and phenomenally low in price. All models are **IN STOCK!** So contact Mini-Circuits now for individual units, or buy the 2MHz to 12.6GHz Designer's Kit for the lab, and never get caught short. Have the signal splitting power you need, on hand when you need it, with ZX10!

Mini-Circuits...we're redefining what VALUE is all about!

Typical Specifications

Model	Frequency (GHz)	Isolation (dB)	Insertion Loss (dB) Above 3.0dB	Price \$ea. (Qty. 1-24)
ZX10-2-12	.002-1.2	21	0.5	24.95
ZX10-2-20	.2-2	20	0.8	24.95
ZX10-2-25	1-2.5	20	1.2	26.95
ZX10-2-42	1.9-4.2	23	0.2	34.95
ZX10-2-71	2.95-7.1	23	0.25	34.95
ZX10-2-98	4.75-9.8	23	0.3	39.95
ZX10-2-126	7.4-12.6	23	0.3	39.95

Dimensions: 0.74"x0.50"x0.54"



K1-ZX10 Designer's Kit
1 of Each Model (7 total) \$199.95
FREE Deluxe Wood Storage Case!

Detailed Performance Data & Specs Online at: www.minicircuits.com/zx10-series.pdf

Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



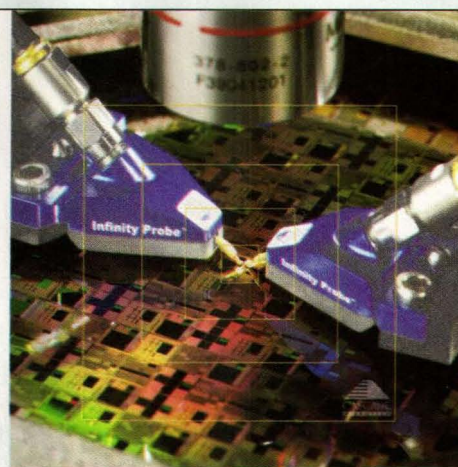
The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001, ISO 14001 CERTIFIED

383 rev. orig.

cover story

On-Wafer Probes Test Silicon ICs To 110 GHz



Thin-film lithographic technology helps to define the precise features of probes with the low contact resistance needed to accurately characterize emerging silicon-based high-frequency devices.

Silicon-device technologies were once considered appropriate for digital and/or RF applications at best. But with the steady development of such advanced technologies as silicon complementary metal-oxide semiconductor (CMOS) and silicon-germanium (SiGe) bipolar CMOS (BiCMOS), millimeter-wave silicon devices are becoming a reality.

Testing such high-frequency, high-speed devices offers a serious challenge to suppliers of on-wafer probes, a challenge that has been taken up by Cascade Microtech (Beaverton, OR) with the introduction of their Infinity Probes™. The new technology enables low and stable probe contact resistance while supporting on-wafer measurements on silicon devices through 110 GHz.

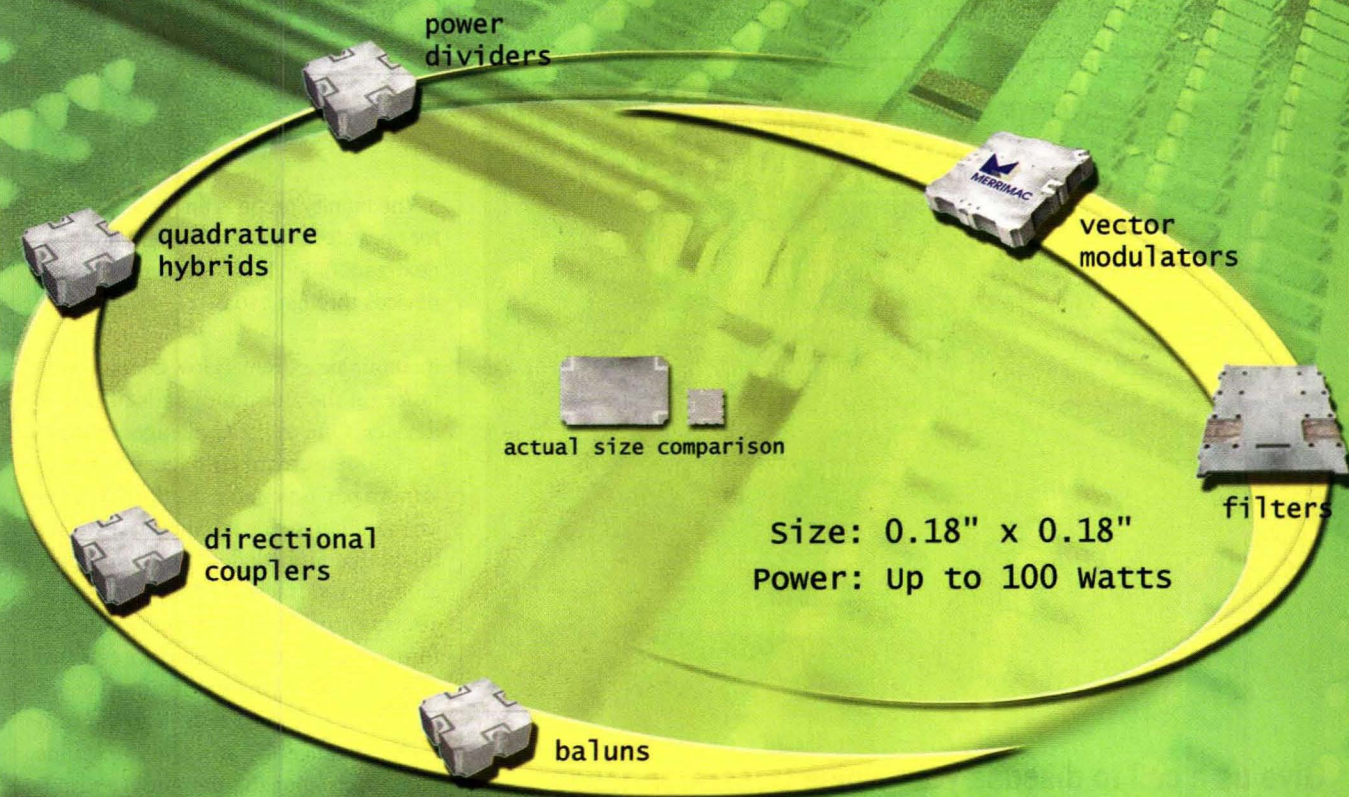
Although silicon CMOS and SiGe devices for millimeter-wave *operation* are not common, an essential part of characterizing and modeling such devices involves the extraction of transition frequencies (f_T 's). Since the International Technology Roadmap for Semiconductors (ITRS) projects the f_T of analog CMOS devices to increase from a current high of 150 GHz to a frequency of 370 GHz by 2007, with a similar track for SiGe, there is a strong need for a probe technology that can accurately measure on-wafer signals without degrading the electrical quality of those signals.

A wafer probe, of course, provides the critical signal path between a device under test (DUT) and the measurement equipment, typically a vector network analyzer (VNA). To improve measurement integrity when testing

JACK BROWNE
Publisher/Editor

Think about this...

Multi-Mix[®], "the PICO standard" for smart SIZE:POWER RF solutions

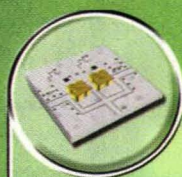


Multi-Mix[®] PICO Design Flexibility... Components to Integrated Modules



**Multi-Mix
PICO[™]
Components**

Miniaturized MW Components
Open Architecture
Flexibility
Surface Mount
For Your Integration



**Multi-Chip
Modules
(MCM)**

Pre-Mounted
Pre-Tested
Surface Mount
Connectorized
Prototype Toward Integration
"Known" Good Module



**Integrated
Modules**

High-Level Integration
Size Reduction
Better Power Handling/Reliability
Surface Mount
EMI/RFI Shielding
"Known" Good Module



**Micro-
Multifunction
Modules
(MMFM[®])**

Multilayer Integrated MMFM[®]
"Known" Good Module
Pre-Tested
Cost Effective

silicon devices, the design of the Infinity probes has been optimized for probing aluminum pads. This is the most commonly used metalization for silicon process wafers, in contrast to the gold metalization usually found on III-V semiconductor devices, such as gallium

arsenide (GaAs). In a silicon process, gold (Au) is a contaminant that can cause deep level traps in a CMOS process, for example.

The Infinity probes (Fig. 1) benefit from a new technology that delivers excellent high-frequency performance while



1. The Infinity probe is an ideal solution for on-wafer probing of current and next-generation high-frequency silicon devices through 110 GHz.

Need precise Noise?



CNG series

- ◆ Standard models available to 3GHz
- ◆ Custom solutions to 30GHz
- ◆ Noise attenuator resolution 0.015dB
- ◆ Extremely fast execution time
- ◆ Reliable solid state design



WGN series

Give us a call to discuss your Noise Generator needs...

CNG Series

The CNG series allows carrier to noise (C/N) or carrier to interference (C/I) ratios to be easily programmed in a user specified occupied signal bandwidth. The instrument can automatically track and remove signal variations to maintain a precise noise ratio. At the heart of the instrument is a temperature stabilized "smart" noise attenuator with 0.015dB resolution and 95dB dynamic range.

Carrier/Noise (CNG) Series	
Model	Frequency range
CNG-26/180	26MHz - 180MHz
CNG-70/140	50MHz - 180MHz
CNG-800/1000	800MHz - 1000MHz
CNG-870/1750	870MHz - 1750MHz
CNG-800/2400	800MHz - 2400MHz
CNG-1700/2400	1700MHz - 2400MHz
CNG-2200/2700	2200MHz - 2700MHz
CNG-800/2700	800MHz - 2700MHz

WGN Series

The WGN series is a cost effective, highly accurate Additive White Gaussian Noise generator with a oven stabilized noise source (with high crest factor) and a precision temperature stabilized noise attenuator. It is ideally suited for noise applications requiring extremely accurate and repeatable White Gaussian Noise.

Broadband Noise (WGN) Series	
Model	Frequency range
WGN-1/200	1MHz - 200MHz
WGN-5/1005	5MHz - 1005MHz
WGN-800/1000	800MHz - 1000MHz
WGN-870/1750	870MHz - 1750MHz
WGN-800/2400	800MHz - 2400MHz
WGN-100/3000	100MHz - 3000MHz

Please consult factory for additional models

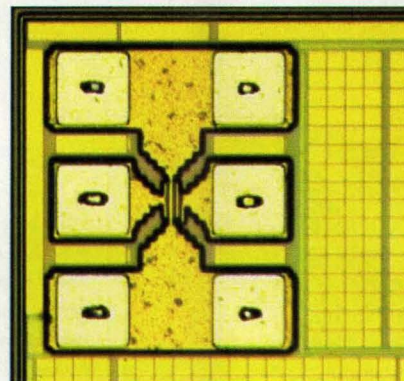
dBm, LLC

6 Highpoint Drive ♦ Wayne, NJ 07470
Tel (973) 709-0020 ♦ Fax (973) 709-1346

www.dbmcorp.com

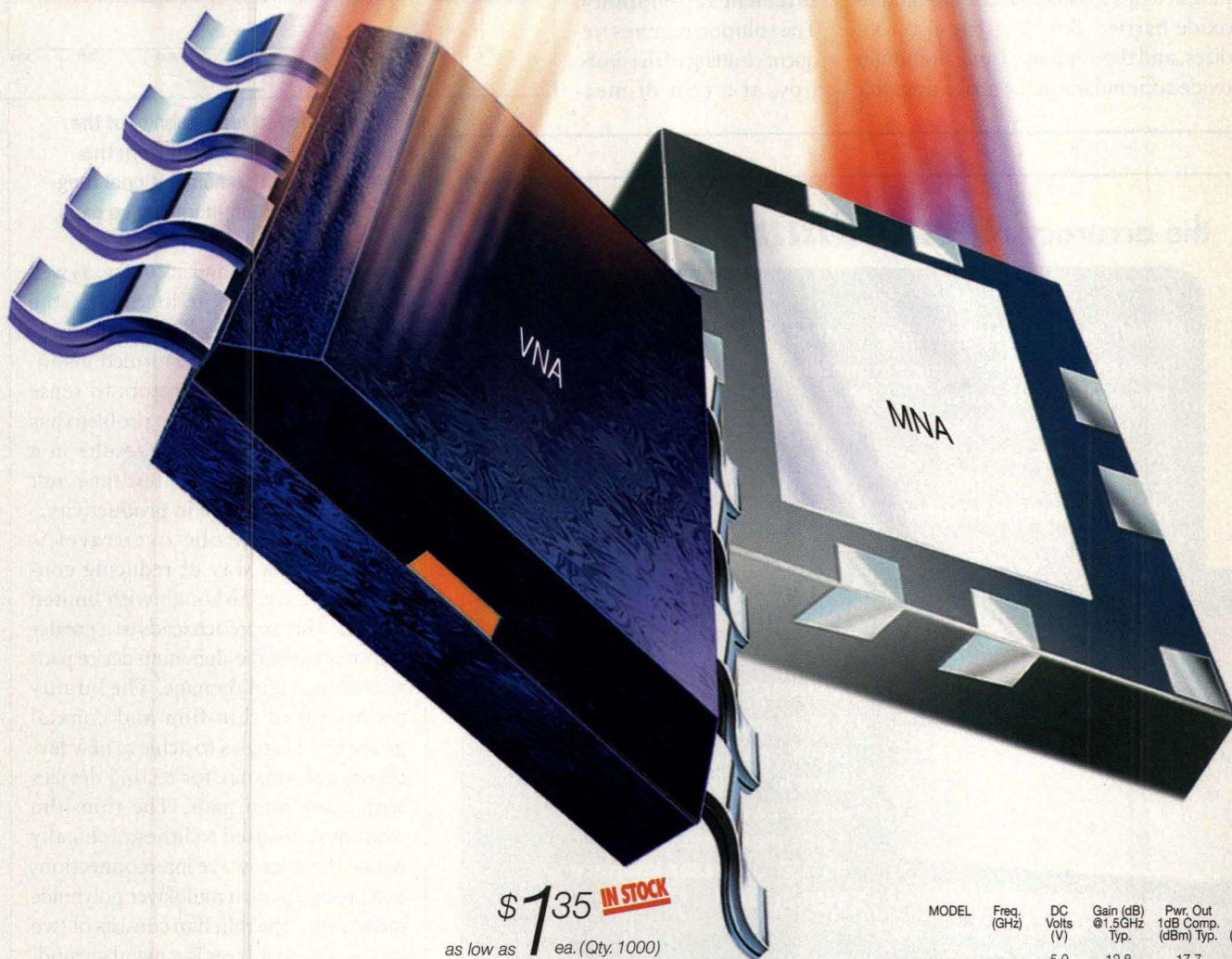


RF Test Equipment for Wireless Communications



2. A combination of excellent tip visibility and small contact marks enable reliable and repeatable on-wafer probing of silicon devices with 50 × 50-μm pads.

500MHz-5.9GHz MMIC AMPLIFIERS

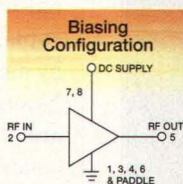


\$135 **IN STOCK**

as low as \$135 ea. (Qty. 1000)

Built-In RF Choke, Resistors, Bypass & Coupling Capacitors

Simplify your 500MHz to 5.9GHz designs with Mini-Circuits easy to use MNA and VNA amplifiers. With DC blocking capacitors and a biasing network built-in, all you do is drop the amplifier in place on your PC board, connect, and the job is done! There's no biasing to figure out and no external components to connect. Broadband low and high power models offer gain from 9 to 23dB and power output from 7 to 19dBm. High isolation, typically greater than 40dB, makes them terrific for use as an isolator. And the versatility to operate from a



+2.8 to +5V DC supply makes them perfect for today's miniature battery operated hand-held devices. Two different package styles are available; MNA's leadless 3x3mm MCLPTM (Mini-Circuits Low Profile) SM package with exposed metal bottom for excellent grounding and heat dissipation, and VNA's leaded SOIC-8 for easier assembly...all value priced and ready to ship! So simplify your design, your manufacturing, and your life with Mini-Circuits all-in-one MNA and VNA MMIC amplifiers.

Mini-Circuits...we're redefining what VALUE is all about!

	MODEL	Freq. (GHz)	DC Volts (V)	Gain (dB) @1.5GHz Typ.	Pwr. Out 1dB Comp. (dBm) Typ.	Price \$ea. (qty. 30)
ACTUAL SIZE	MNA-2	0.5-2.5	5.0 2.8	12.8 11.2	17.7 12.9	1.90
	MNA-3	0.5-2.5	5.0 2.8	16.1 15.0	11.4 9.7	1.60
	MNA-4	0.5-2.5	5.0 2.8	16.4 14.5	19.0 13.4	1.90
	MNA-5	0.5-2.5	5.0 2.8	21.9 20.5	12.2 10.1	1.60
	MNA-6	0.5-2.5	5.0 2.8	23.6 21.2	18.0 14.1	2.25
	MNA-7	1.5-5.9	5.0 2.8	15.9 13.7	15.6 12.7	2.25
	VNA-21	0.5-2.5	5.0 2.8	13.5 12.3	8.5 7.0	1.80
	VNA-22	0.5-2.5	5.0 2.8	13.8 12.6	17.0 14.0	2.20
	VNA-23	0.5-2.5	5.0 2.8	18.3 17.1	10.0 8.5	1.90
	VNA-25	0.5-2.5	5.0 2.8	18.6 17.4	18.2 12.0	2.50
	VNA-28	0.5-2.5	5.0 2.8	22.8 21.0	11.0 9.6	1.95

Detailed Performance Data & Specs Online at: www.minicircuits.com/amplifier.html

Amplifier Designer's Kits

K1-MNA: 10 of ea. MNA-2, 3, 5, 6...\$69.95

K2-MNA: 10 of ea. MNA-2, 3, 4, 5, 6, 7...\$99.95

Application note for PCB layout included.

Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

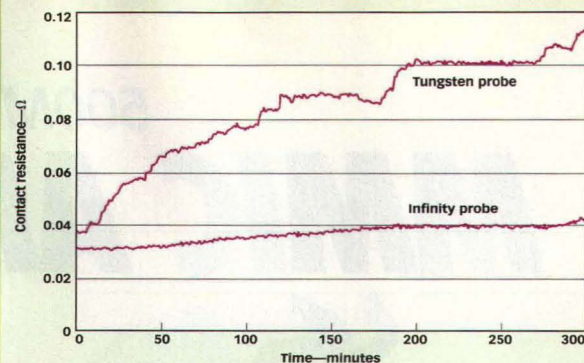
ISO 9001 ISO 14001 CERTIFIED

389 Rev. Org.

devices and tests that require long duration (more than a few minutes each).

Conventional RF coaxial probes use tungsten tips to penetrate the aluminum-oxide barrier. But tungsten also oxidizes, and the aluminum and aluminum oxide accumulate on the probe tips after

only a few contacts, increasing the contact resistance and resulting in poor measurement repeatability. The solution requires frequent cleaning of the probe tips, at a cost of mea-

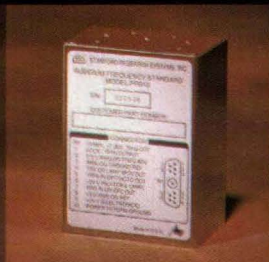


the accuracy of *Rubidium*...

PRS10 Rubidium Oscillator (10 MHz)

- Less than 5×10^{-11} aging per month
- Ultra low phase noise (-130 dBc/Hz @ 10 Hz)
- 20 year lamp life
- 1 pps input and output
- RS-232 computer interface

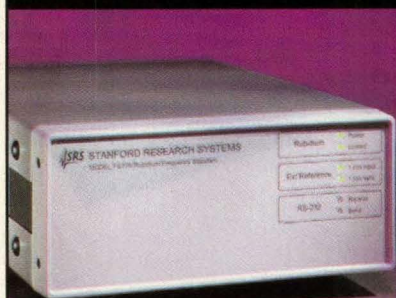
\$1495 (U.S. list)



FS725 Benchtop Rubidium Frequency Standard

- 5 MHz and 10 MHz outputs
- 0.005 ppm aging over 20 yrs.
- Built-in distribution amplifier (up to 22 outputs)
- 1 pps input and output
- RS-232 computer interface

\$2495 (U.S. list)



SRS rubidium frequency standards have excellent aging characteristics, extremely low phase noise and outstanding reliability.

The PRS10 component rubidium oscillator is designed for easy system integration. It has a 1 pps input for phase-locking to an external reference (like GPS) and provides 72 hour Stratum 1 level holdover.

The FS725 benchtop instrument is ideal for the metrology laboratory as well as the R&D facility – anywhere precision frequency is required. It generates 5 MHz and 10 MHz signals and has a built-in distribution amplifier with up to 22 outputs.



Stanford Research Systems

1290-D Reamwood Ave. Sunnyvale, CA 94089 • email: info@thinkSRS.com
Phone (408) 744-9040 • Fax (408) 744-9049 • www.thinkSRS.com

3. The improved repeatability of the Infinity probe is apparent from this comparison with a conventional tungsten probe on aluminum-device pads.

surement integrity and accuracy, as well as a reduction in the lifetime of the probes. Due to this limitation, measurements are often performed manually, using skilled operators to sense when a contact resistance problem has occurred. However, this results in a considerable increase in test time, test cost, and a reduction in productivity.

Often, the probe overtravel is increased as a way of reducing contact resistance, although with limited success. This approach leads to a greater deformation of the aluminum device pads and serious pad damage. The Infinity probes blend thin-film and coaxial probe technologies to achieve new levels of performance for testing devices with aluminum pads. The thin-film technology is used to lithographically define the microwave interconnections and probe tips on a multilayer polyimide membrane. The thin film consists of two layers. The first layer is a metal ground-plane layer. The second layer routes signal conductors. The microstrip-to-coplanar-tip connections are routed by means of photoprocessed via holes. Nonoxidizing nickel-alloy probe tips are plated and connected to different conductor layers by means of the via holes. The fabrication approach ensures a tightly controlled 50-Ω impedance while maintaining excellent signal integrity. This structure also ensures that the electromagnetic (EM) fields are confined within the dielectric material, thereby suppressing microwave-transmission losses and reducing coupling to adjacent structures.

The Infinity probes feature typical and consistent contact resistance of less than 0.05 Ω. The probe contact area is

BUILD YOUR FUTURE WITH SAWTEK!

Sawtek delivers a full line of RF SAW filters for all your design needs. Our expanded capacity and product portfolio make Sawtek your supplier of choice. These products – plus a complete line of SAW filters for worldwide wireless architectures – are setting a new standard for performance and dependability.



SAWTEK'S DUPLEXERS

Frequency (MHz)	Application	Mode
836.0/881.0	Cellular Duplexer	SE
1765.0/1855.0	KPCS Duplexer	SE

Sawtek...Your Supplier of Choice!

SAWTEK'S RF FILTERS

Frequency (MHz)	Application	Mode
836.5	Cellular Tx	SE
881.5	Cellular Rx	SE
881.5	Cellular Rx	SE/BAL 100 Ω
942.5	EGSM Rx	SE
942.5	EGSM Rx	SE/BAL 50 Ω
942.5	EGSM Rx	SE/BAL 200 Ω
1575.0	GPS Rx	SE
1575.0	GPS Rx	SE/BAL 100 Ω
1765.0	KPCS Tx	SE
1842.5	DCS Rx	SE/BAL 50 Ω
1842.5	DCS Rx	SE/BAL 200 Ω
1855.0	KPCS Rx	SE
1855.0	KPCS Rx	SE/BAL 100 Ω
1880.0	U.S. PCS Tx	SE
1960.0	U.S. PCS Rx	SE
1960.0	U.S. PCS Rx	SE/BAL 100 Ω
1960.0	U.S. PCS Rx	SE/BAL 200 Ω



SAWTEK
a TriQuint company

www.sawtek.com

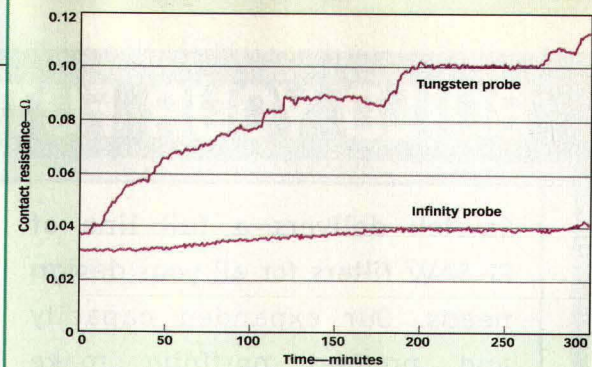
Phone: (407) 886-8860

Fax: (407) 886-7061

E-mail: info@sawtek.com

about $12 \times 12 \mu\text{m}$, with clear contact marks to enable probing of devices with miniature $50 \times 50\text{-}\mu\text{m}$ aluminum pads (Fig. 2). An innovative force delivery technique requires that only a small horizontal scrubbing movement is needed to break through the typical 60-

Angstrom aluminum-oxide barrier. The vertical over-travel is about 50 to 75 μm , resulting in a required scrub movement of only about 25 μm . Since these minimal movements pro-



4. Compared to a tungsten probe, only 10-m Ω variations in contact resistance occurred for an Infinity probe during a 5-h continuous contact cycle at 100 mA.

vide good electrical contacts to aluminum pads, excellent repeatability is possible with negligible pad damage.

Tests performed on the Infinity probes show consistent typical contact resistance of less than 0.05 Ω over 100,000 probing cycles on aluminum pads (Fig. 3). During a five-hour, single-contact test on aluminum pads, the typical contact-resistance variations were less than 10 m Ω (Fig. 4). The measured attenuation is less than 1.5 dB to 110 GHz, with more than 12 dB return loss to 110 GHz.

The Infinity probes offer tremendous benefits in test productivity and measurement accuracy, along with considerable reduction in cost of ownership. The company currently offers the Infinity probe models i40 (DC to 40 GHz), i50 (DC to 50 GHz), i67 (DC to 67 GHz), and i110 (DC to 110 GHz) with coaxial connectors. The probes are available in ground-signal-ground (GSG) and ground-signal/signal-ground (GS/SG) configurations, with pitches of 100, 125, 150, 200, or 250 μm . Calibration is performed with the help of the company's line of impedance standard substrates (ISS) which have been verified for accuracy at millimeter-wave frequencies. In addition, the company offers WinCal software for accurate calibrations to 110 GHz. Although designed for probing semiconductor devices with aluminum pads, the Infinity probes are also suitable for testing gold-metallized devices. Cascade Microtech, Inc., 2430 NW 206th Ave., Beaverton, OR 97006; (800) 550-3279, (503) 601-1000, FAX: (503) 601-1002, e-mail: sales@cmicro.com, Internet: www.cascademicrotech.com.

TRIMMER CAPACITORS

www.VoltronicsCorp.com

IF ONE OF OUR THOUSANDS OF
CATALOG PARTS DO NOT MEET
YOUR REQUIREMENTS WE WILL
DESIGN YOUR TRIMMER CAPACITOR



Voltronics
CORPORATION
The Trimmer Capacitor Company

100 Ford Road • Denville, NJ 07834
973.586.8585 • Fax: 973.586.3404
e-mail: info@voltronicscorp.com



ANSOFT DESIGNER™

Electromagnetically Charged EDA Software

From the company that brought you HFSS™, comes a new era of electromagnetically charged EDA software. Ansoft Designer's world-class circuit, system, and electromagnetic technology will redefine the way you design. To learn more, visit

www.ansoft.com/ansoftdesigner



Veteran Cap Supplier Unleashes New TCXOs

Long known as a leading supplier of trimmer capacitors, this respected firm has just launched a line of low-cost, stable crystal oscillators for low-power wireless applications.

Temperature-compensated crystal oscillators (TCXOs) and voltage-controlled TCXOs (VCTCXOs) serve as frequency and time references in a wide range of systems, including in cellular and personal-communications-services (PCS) systems. A company once known as the supplier of tuning elements for these oscillators, Voltronics Corp. (Denville, NJ), has now added extensive lines of low-cost TCXOs and

+5.0 VDC in standard and miniature SMD packages as well as 14-pin DIP packages. Frequency variations versus supply

are better than ± 0.2 PPM for all models for a 5-percent change in either supply.

Logic-output models in the 300 and 500 series feature maximum rise/fall time of 4 ns for HCMOS while those with the TTL options have maximum rise/fall times of 3 ns. Current consumption for these models is less than 25 mA. Models in the 400 and 600 series feature clipped sinewave outputs with similar current consumption of 25 mA. All models are offered with a wide range of standard temperature/stability levels (see table), with custom levels available. An aging rate of 1 PPM/yr is standard for all models, as is single-sideband (SSB) phase noise of better than -125 dBc/Hz offset 1 kHz from the carrier.

Voltage-controlled models in the 500 and 600 series offer electronic tuning capability of ± 5 PPM for ± 2.0 V centered at $+2.5$ VDC for a $+5$ -VDC supply and ± 1.32 V centered at $+1.65$ VDC for a $+3.3$ -VDC supply. Voltronics Frequency Control Products, Inc., 100 Ford Rd., Denville, NJ 07834; (973) 586-8585, FAX: (973) 586-3404, e-mail: info@voltronicsfcp.com, Internet: www.voltronicsfcp.com.

VCTCXOs from 4 to 40 MHz. The low-power oscillators are available in both dual-in-line packages (DIPs) and standard and miniature surface-mount housings.

The initial TCXO product offerings include the 300 and 400 series, and the initial VCTCXO products are the 500 and 600 series. HCMOS or TTL (300 and 500 series) and clipped sinewave output signals (400 and 600 series) are available. Standard output frequencies are 10.0, 12.8, 13.0, 16.384, 16.8, 19.44, 20.0, 20.48, 27.0, and 38.88 MHz, with custom frequencies available from 4 to 40 MHz. All of the oscillators provide mechanical tuning of at least ± 3 PPM. In addition, the 500 and 600 series oscillators include elec-

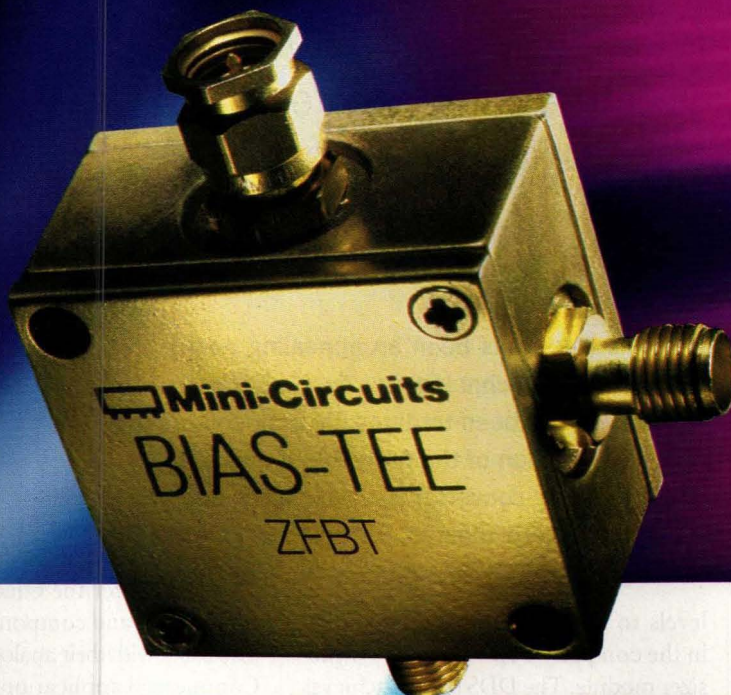
tronic frequency control over a minimum range of ± 10 PPM. All of the oscillators can be set to an initial accuracy of ± 1 PPM at $+25^\circ\text{C}$.

All four source series can be specified for use with $+3.3$ or

JACK BROWNE
Publisher/Editor

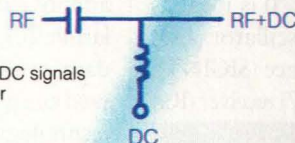
Temperature-stability options

STABILITY LEVEL	TEMPERATURE RANGE	STABILITY
A057	+15 to $+35^\circ\text{C}$	± 0.5 PPM
B106	0 to $+50^\circ\text{C}$	± 1.0 PPM
C156	0 to 70°C	± 1.5 PPM
D206	-20 to $+70^\circ\text{C}$	± 2.0 PPM
E256	-30 to $+75^\circ\text{C}$	± 2.5 PPM
F406	-40 to $+85^\circ\text{C}$	± 4.0 PPM



BIAS TEES

From **\$25⁹⁵**



Easily combines RF+DC signals for your modulation or test requirements.

Now up to 500mA DC current 100kHz-6GHz

With Mini-Circuits Bias-Tees, you can DC connect to the RF port of an active device without effecting its RF properties...modulate a laser, apply DC to an amplifier output, and more! Using statistical process control plus combining magnetics and microstrip, large DC currents may pass through the Bias-Tee without saturation and degradation of performance. At 1/3 to 1/4 the price of competitive units, these new Bias-Tees are available in surface mount, pin, and connectorized models. So why wait, solve your connection problems with Mini-Circuits Bias-Tees.



Mini-Circuits...we're redefining what VALUE is all about!

Model	Freq (MHz) F ₁ -F ₂	Insertion Loss (dB Typ.)			Isolation (dB Typ.)			VSWR (Typ.) U	Price \$ ea 1-9 qty.
		L	M	U	L	M	U		
▲ZFBT-4R2G	10-4200	0.15	0.6	0.6	32	40	50	1.13:1	59.95
▲ZFBT-6G	10-6000	0.15	0.6	1.0	32	40	30	1.13:1	79.95
▲ZFBT-4R2GW	0.1-4200	0.15	0.6	0.6	25	40	50	1.13:1	79.95
▲ZFBT-6GW	0.1-6000	0.15	0.6	1.0	25	40	30	1.13:1	89.95
▲ZFBT-4R2G-FT	10-4200	0.15	0.6	0.6	N/A	N/A	N/A	1.13:1	59.95
▲ZFBT-6G-FT	10-6000	0.15	0.6	1.0	N/A	N/A	N/A	1.13:1	79.95
▲ZFBT-4R2GW-FT	0.1-4200	0.15	0.6	0.6	N/A	N/A	N/A	1.13:1	79.95
▲ZFBT-6GW-FT	0.1-6000	0.15	0.6	1.0	N/A	N/A	N/A	1.13:1	89.95
★ZNBT-60-1W	2.5-6000	0.2	0.6	1.6	75	45	35	1.35:1	82.95
■PBTC-1G	10-1000	0.15	0.3	0.3	27	33	30	1.10:1	25.95
■PBTC-3G	10-3000	0.15	0.3	1.0	27	30	35	1.60:1	35.95
■PBTC-1GW	0.1-1000	0.15	0.3	0.3	25	33	30	1.10:1	35.95
■PBTC-3GW	0.1-3000	0.15	0.3	1.0	25	30	35	1.60:1	46.95
●JEBT-4R2G	10-4200	0.15	0.6	0.6	32	40	40	-	39.95
●JEBT-6G	10-6000	0.15	0.7	1.3	32	40	40	-	59.95
●JEBT-4R2GW	0.1-4200	0.15	0.6	0.6	25	40	40	-	59.95
●JEBT-6GW	0.1-6000	0.15	0.7	1.3	25	40	30	-	69.95

L = Low Range M = Mid Range U = Upper Range

NOTE: Isolation dB applies to DC to (RF) and DC to (RF+DC) ports.

▲SMA Models, FT Models Have Feedthrough Terminal ★Type N, BNC Female at DC

■Pin Models ●Surface Mount Models

Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: <http://www.minicircuits.com>

ISO 9001 CERTIFIED

F 164 Rev B

Compact DDS Silences Spurious And Phase Noise

Proprietary circuitry helps this modular DDS to achieve impressive phase-noise and spurious levels from 20 MHz to 3 GHz.

direct-digital synthesis (DDS) has been an appealing commercial and military source technology for over a decade. One limitation, however, has been traditionally poor spurious performance, as a function of the bit resolution of the DDS and its digital-to-analog-converter (DAC) circuitry. Fortunately, Advanced Radio Corp. (Reston, VA) has developed proprietary circuitry to effectively reduce DDS spurious

applications. The digital circuits used to implement signal-processing functions do not suffer the effects of thermal

PAUL JACKSON

Chief RF Engineer

SCOTT HARDY

Senior Design Engineer

CHRIS MARTINS

Product Manager

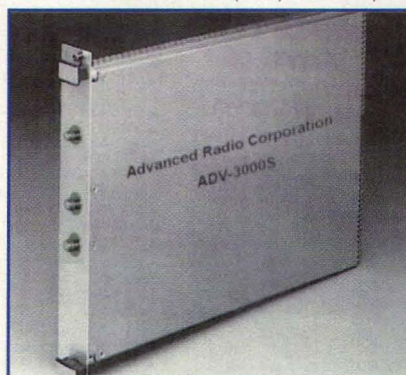
Advanced Radio Corp., 1800
Alexander Bell Dr., Reston, VA, 20190;
(703) 435-5900, FAX: (703) 435-1110,
e-mail: cmartins@advradio.com,
Internet: www.advradio.com.

levels to a bare minimum, embodied in the company's ADV-3000S synthesizer module. The DDS source achieves spurious levels of typically better than -90 dBc from 20 MHz to 3 GHz; the basic architecture can be extended to 18 GHz.

The ADV-3000S (**Fig. 1**) is ideal as a programmable local oscillator (LO) for radar, signal-intelligence (SIGINT), and electronic-warfare (EW) receiver (Rx)


drift, aging, and component variations associated with their analog counterparts. Commercial applications include base stations, high-data-rate communications links, and test equipment including signal generators and spectrum analyzers. Through programming, the DDS adaptive-channel bandwidths, modulation formats, frequency hopping, and data rates are easily changed. When used as a quadrature synthesizer, the DDS technology affords unparalleled matching and control of in-phase (I) and quadrature (Q) outputs. In its simplest form, a direct digital synthesizer can be implemented from a precision reference clock controlling a numerically controlled oscillator (NCO), a sine look-up table, programmable read-only memory (PROM), and a DAC.


The ADV-3000S synthesizer operates from 20 MHz to 3.0 GHz with standard tuning resolution of 1 Hz, although its flexible architecture supports a variety of step sizes. It tunes to a new frequency in less than 5 μ s, and delivers typical output-power levels of



1. The ADV-3000S DDS module incorporates proprietary spurious-canceling circuitry to achieve low noise performance from 20 MHz to 3 GHz.

FILTERS

 **LTCC .12"x.06"**
LFCN (low pass)
5 models DC-2400MHz

 **LTCC .15"x.15"**
LFTC (low pass)
7 models DC-5400MHz
HFTC (high pass)
5 models 1300-7000MHz

 **LTCC .7"x.3"**
LPCH (low pass)
4 models DC-900MHz

 **Discrete .7"x.3"**
SCLF (low pass) 24 models
DC-1000MHz
SALF (low pass) 11 models
DC-865MHz
SCHF (high pass) 3 models
18-1200MHz

4.7MHz to 10GHz from **99¢** ea. qty. 1000
10 pcs. \$1.99 ea.

Using leading edge Low Temperature Co-fired Ceramic (LTCC) technology, Mini-Circuits has introduced an extensive variety of new Blue Cell™ filters giving you the advantages of smaller size, excellent repeatability, and high power handling at very low cost. Choose from units as small as a chip resistor, a mere 0.12"x0.06" in size, rejection frequency bands up to 5GHz, and prices from less than \$1. Other models offer superb performance up to 10GHz. In addition, take your pick from over 35 discrete component models offering wide bandwidths and cut-off frequencies as low as 4.7MHz, all at industry low prices with immediate off-the-shelf availability. You can quickly find the model you need on our web site through the "online catalog" and "new products" links. If you have requirements not shown, ask us! We will let you know right away if we can do it and have it for you within 2 weeks. So contact Mini-Circuits today. Our team is ready to work with you worldwide!

Mini-Circuits...we're redefining what VALUE is all about!

 **Mini-Circuits®**

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001 ISO 14001 CERTIFIED

390 Rev B

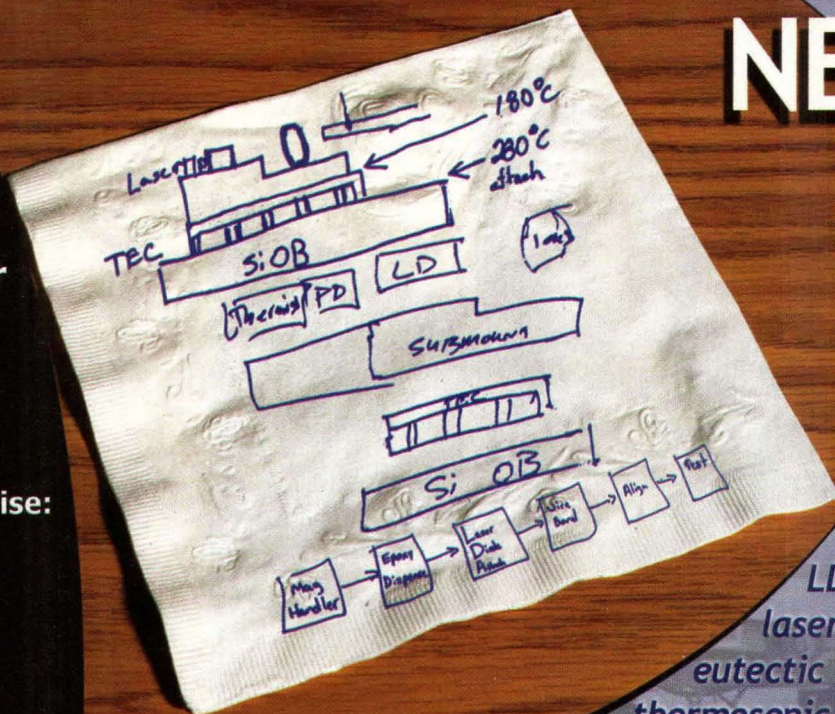
See our 244 page RF/IF Designer's Guide in EEM (Electronic Engineers Master)

GREAT IDEA ...WHAT'S NEXT?

We take your ideas from concept to production.

Packaging Expertise:

- Design
- Prototyping
- Pilot Builds
- Telcordia™ qualification



MEMS
flip chip
butterfly
mini-dil
v-groove

LDMOS

laser solder

eutectic

thermosonic

thermocompression

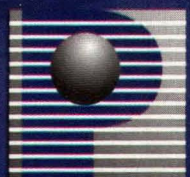
active alignment

passive alignment

Palomar's Process Development and Prototyping Services has the equipment and expertise to help you design, build, and qualify your broadband components. Let us validate your process on our fully automated production equipment before you invest.

Don't leave your ideas on the table.

Call the experts at (760) 931-3762 or visit www.palomartechnologies.com to get started today.



®

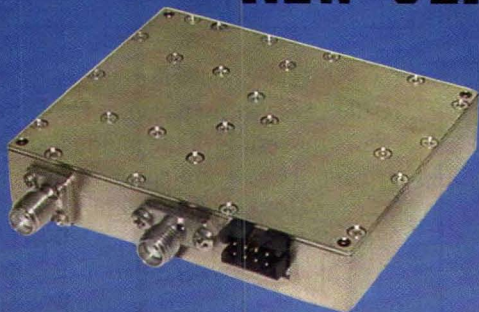
**PALOMAR
TECHNOLOGIES**

Enabling Lightwave Connectivity

SYNTHESIZER SOLUTIONS

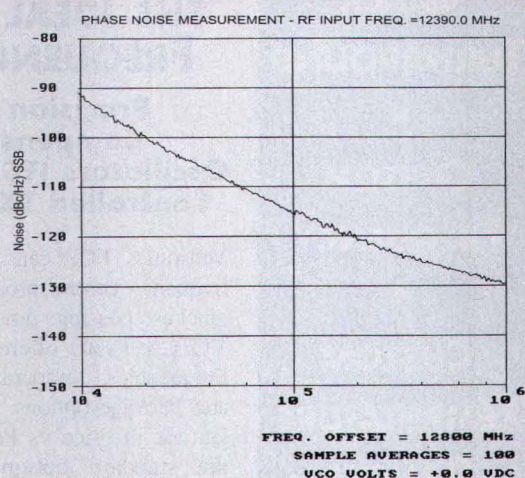
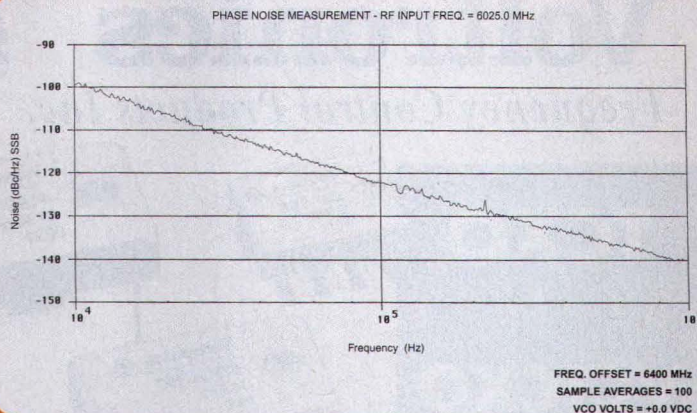
NEW ULTRA LOW COST

MINIATURE SERIES VSS



The Series VSS are miniature microwave synthesizers designed for low cost, high data rate, digital radio, VSAT and SatCom applications. The Synthesizers are optimized for use in LMDS and digital radio systems where low cost and high flexibility are priorities. Its very small package is suitable for mounting in space-limited Up/Down Converter integrated assemblies.

- 500 MHz to 14 GHz (in Bands)
- Miniature Package for Drop-In Mounting
- Output Power +12 to +17 dBm
- DC Supply Voltage +5 Vdc at 275 mA typ;
80 mA for 500-2000 MHz
+15 Vdc at 40 mA typ.
- Operating Temperature (case) -10 to 70°C
standard; optional -30°C to +80°C
- Bandwidths 5-17%
- Low Power Consumption
- Very Low Phase Noise at high offsets
- Locks To 5 - 100 MHz External Reference
- High Phase Hit Immunity and Microphonics
- Synthesizes with optional Integrated IFLO
Meet SATCOM IESS 308/309 specification
@ CBand



GET THE PERFORMANCE YOU NEED AT THE PRICE YOU WANT

CALL THE EXPERTS!



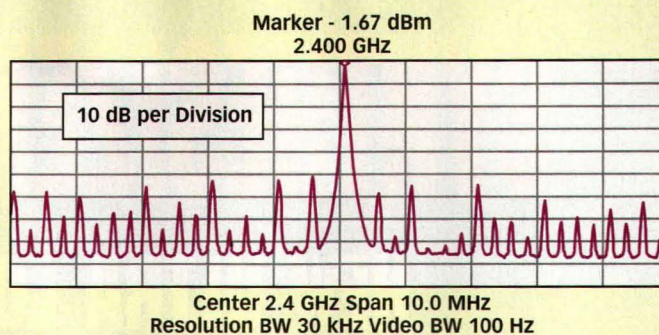
9 Whippany Rd. • Whippany, NJ 07981
TEL: 973-884-2580 • FAX: 973-887-6245
www.cti-inc.com • e-mail: sales@cti-inc.com



PRODUCT *technology*

+10 dBm. The measured phase noise is better than -108 dBc/Hz offset 10 Hz from a 104.85-MHz carrier and -142.6 dBc/Hz offset 100 kHz from the same carrier. Verifying such low phase noise required using the 20logN noise multiplication relationship to derive phase-noise levels at

2. This plot shows the spurious outputs for an uncompensated DDS source at 2.4 GHz.



Voltronics

Frequency Control Products Inc.



TCXO
•
VCTCXO

QUICK
TURNAROUND

CUSTOM
FREQUENCY

CUSTOM
TEMPERATURE
RANGES

REASONABLE
PRICES

SMALL
QUANTITIES



THE IDEAL CHOICE FOR FREQUENCY CONTROL

**Precision Temperature
Compensated Crystal
Oscillators (TCXOs) and Voltage
Controlled TXCO's (VCTCXOs).**

Voltronics FCP can provide reasonably priced frequency control products at any quantity in the quickest possible time frame. The TCXO's and VCTCXO's are offered in a number of Standard Frequencies, Temperature Stability, Input/Output and Package options, giving the designer a wide latitude in Price vs Performance criteria. Should the standard options offered not meet the designer's needs, small quantity custom parts can be provided in a reasonable time frame and often without large NRE charges.

- Wireless • PCS • GSM • PC • Telecom
- Radio Communications • Instrumentation

www.voltronicsfcp.com

Voltronics

Frequency Control Products Inc.



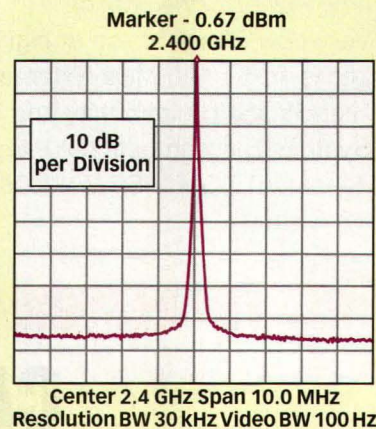
100 Ford Road, Denville, NJ 07834

• Phone: 973-586-8585 • Fax: 973-586-3404

• Email: info@voltronicsfcp.com

lower-frequency carriers from measured results at higher frequencies. The table shows the results of the multiplication process. For example, the measured phase noise offset 100 kHz from a 2201.85-MHz carrier is -112.2 dBc/Hz. The 20logN noise degradation of noise as the result of a 21-times multiplication of a 104.85-MHz carrier (to produce 2201.85 MHz) is 26.4 dB. So, to derive the interpolated unmultiplied carrier phase noise floor at 104.85 MHz, this 26.4 dB is subtracted from the measured noise floor of -112.2 dBc/Hz to yield a noise floor of -142.6 dBc/Hz offset 100 kHz from a 104.85-MHz carrier.

The ADV-3000S DDS offers fast frequency agility as well as control of phase hops/modulation and phase-continuous frequency hops with none of the overshoot or undershoot associated with analog phase-locked loops (PLLs). In fact, the synthesizer support a wide range of modulation formats, including quadrature phase-shift keying (QPSK), quadrature amplitude modulation (QAM), binary phase-shift keying (BPSK), frequency modulation (FM), amplitude modula-



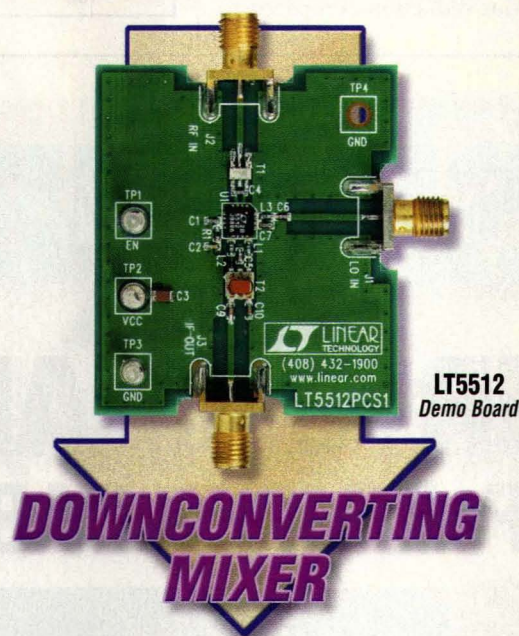
3. The spurious noise is reduced by better than 30 dB through the use of proprietary cancellation techniques.

RF Active Mixer ICs

High Linearity, DC-3GHz



LT5511
Demo Board



LT5512
Demo Board

IIP3 Up to +21dBm at 950MHz; +17dBm at 1900MHz

Our new LT[®]5511 and LT5512 are precision up and down-converting active mixer ICs, respectively, which feature "Best In Class" linearity and excellent port-to-port isolation. Reduced external component count and simplified input/output matching make these ICs easy to use. LO drive requirements are greatly eased by an integrated LO driver with single-ended or differential input. Low distortion operation makes these mixers ideal for use in wireless and cable infrastructure as well as RF instrumentation and radio links.

▼ Features

	Upconverter LT5511	Downconverter LT5512
Conversion Gain	0dB	1dB
IIP3 950MHz	+17dBm	+21dBm
1900MHz	+15.5dBm	+17dBm
IIP2	+52dBm	NA
SSB Noise Figure	15dB	13.3dB
LO-Input Leakage	NA	-53dBm
LO-Output Leakage	-46dBm	-46dBm
LO Drive Level	-15 to -5dBm	-15 to -5dBm
Supply Current	56mA	57mA
Supply Voltage	4V to 5.25V	4.5V to 5.25V
Package	16-Lead SSOP	4mm x 4mm QFN

▼ Data Sheet

www.linear.com/go/5511

▼ Online Store

www.linear.com/lineardirect

▼ More Information

Call: 1-800-4-LINEAR

Visit: www.linear.com

Info: 408-432-1900

Fax: 408-434-0507



LTC and LT are registered trademarks and SwitcherCAD is a trademark of Linear Technology Corporation, 1630 McCarthy Blvd., Milpitas, CA 95035



Become a Linear Insider
www.linear.com/insider

tion (AM), and linear and nonlinear FM chirp. The system also accommodates frequency-shift-keying (FSK) and binary-phase-shift-keying (BPSK) modulation inputs.

The ADV-3000S features impressive spurious reduction compared to

Interpolated phase noise			
OFFSET FROM CARRIER (kHz)	MEASURED PHASE NOISE AT 2201.85 MHz (dBc/Hz)	SUBTRACT $20\log N$ (N = 21) (dB)	EXTRAPOLATED PHASE NOISE AT 104.85 MHz (dBc/Hz)
0.01	-81.4	26.4	-107.8
0.10	-87.4	26.4	-113.8
1	-100.5	26.4	-126.9
10	-111.1	26.4	-137.5
100	-112.2	26.4	-142.6

SPINNER PEAK PERFORMANCE RF JUMPER CABLES



- Suitable for Outdoor Installations (IP-68 Rated)
- Fully Soldered Inner/ Outer Conductors
- Injection Molded Boots for Superior Environmental and Mechanical Protection
- -155 dBc PIM (Dynamic Test Method) Factory Tested/Guaranteed per IEC SC46.WG6
- 100% Factory Tested (VSWR/ Insertion Loss)
- 2 meter, 7-16 to 7-16, 1/2" Super Flexible Jumper Competitively Priced at \$51 (qty 10 pieces)
- Standard & Super Flexible Cable Types Available
- 10 Year Warranty



6350 Regency Pkwy, Suite 500, Norcross, GA 30071 • Tel: 770-263-6326 • Fax: 770-263-6329
www.spinnersna.com • e-mail: sales@spinnersna.com

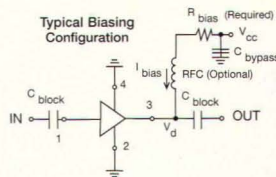
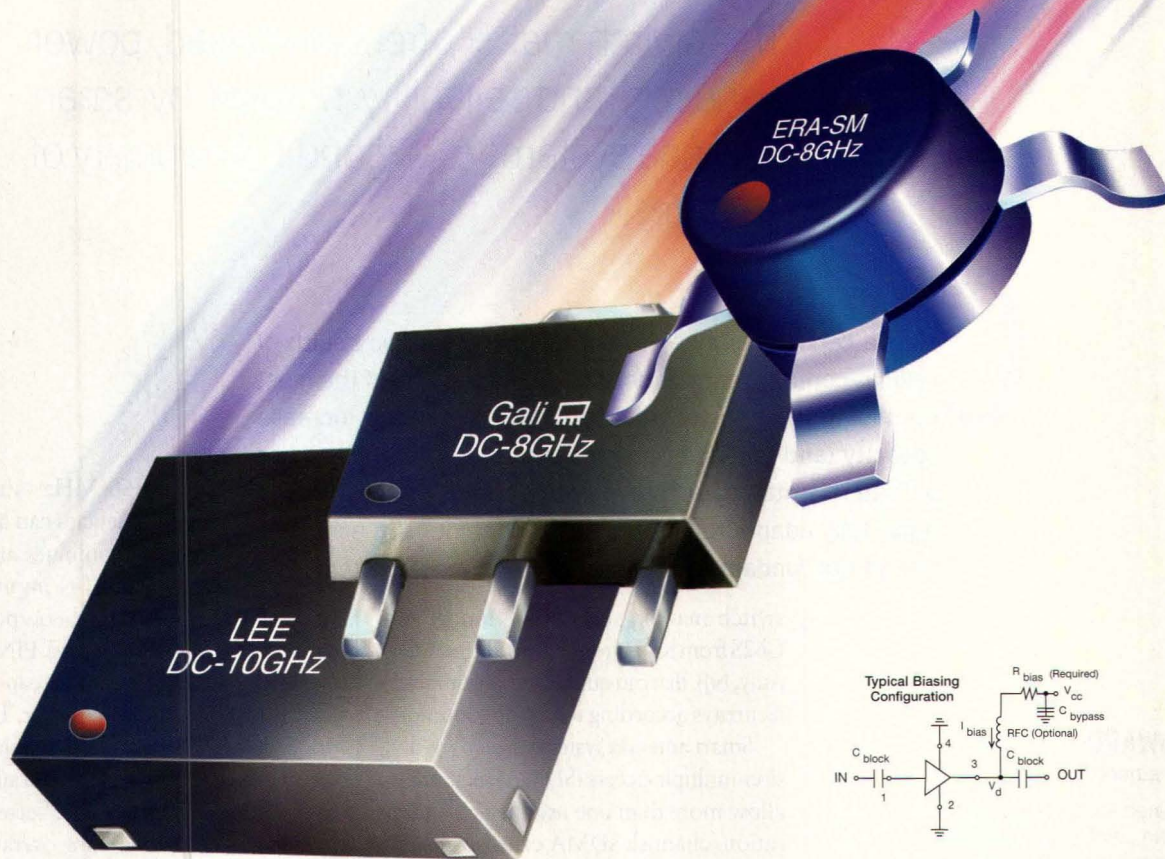
conventional DDS sources. For example, the typical spurious output levels of a 2.4-GHz DDS over a 10-MHz frequency span is -60 dBc (Fig. 2). Using proprietary spurious-canceling circuitry to achieve a better-than 30-dB reduction in output spurious levels compared to conventional DDS sources (Fig. 3).

The ADV-3000S is supplied in a single-slot 6U VME housing measuring 6.5 × 10.3 × 0.8 in. (16.51 × 26.162 × 2.032 cm). It is designed for operating temperatures from 0 to +50°C and consumes less than 17 W of power during normal operation. The standard digital-interface control is through the VME-bus digital interface with optional RS-232 and Ethernet formats. The company has also integrated the ADV-3000S DDS source with the model ADV-3000T very-high-frequency (VHF)/ultra-high-frequency (UHF) downconverter to form a fast-tuning radio solution that operates from 20 MHz to 3 GHz (and can be extended to 18 GHz) with typical noise figure of 10 dB. The input third-order input intercept point is typically +8 dBm, and the output second- and third-order intercept points are +75 and +35 dBm, respectively. The assembly offers standard intermediate frequencies (IFs) of 70 and 140 MHz, with selectable bandwidths of 0.5, 1, 2, 5, 20, and 40 MHz at 70 MHz increasing to 65 MHz at 140 MHz. As with the DDS, the tuning resolution of the downconverter/Rx is 1 Hz with typical phase noise levels of -110 dBc/Hz offset 1 kHz from the carrier, -115 dBc/Hz offset 10 kHz from the carrier, and -125 dBc/Hz offset 100 kHz from the carrier. The typical LO re-radiation levels of -90 dBm. The RF unit is also supplied in a single-slot 6U VME housing. Advanced Radio Corp., 1763 Fountain Dr., Ste. 101, Reston, VA, 20191; (703) 435-5900, FAX: (703) 435-1110, e-mail: cmartins@advradio.com, Internet: www.advradio.com.

IN STOCK

MMIC AMPLIFIERS

DC-10GHz as low as **99¢** ea. (qty. 30)



GAIN FROM 8 up to 23dB, OUTPUT POWER up to +20dBm

If you need to find a MMIC amplifier with just the right performance and size to fit your design, your job just got easier! Introducing Mini-Circuits LEE, Gali, and ERA-SM families. Now you can select from a variety of over 40 broadband InGaP HBT and low noise silicon based models with flat gain from 8 up to 23dB, low to high output power of +2.8 to +20dBm, and very high IP3 up to 36dBm typical. These affordable, rugged, compact amplifiers have low thermal resistance for high reliability, and come in three different



package styles to suit your design layout requirements; the leadless 3x3mm "Mini-Circuits Low Profile" (MCLP™) package with exposed metal bottom for superior grounding and heat dissipation, plus the SOT-89 and Plastic Micro-X with leads for easier assembly. You'll find all the performance specs and data on our web site, plus a wide selection of amplifier Designer's Kits with free test fixture included! So broaden your MMIC amplifier choices and maximize performance with Mini-Circuits LEE, Gali, and ERA-SM.

Mini-Circuits...we're redefining what VALUE is all about!

Detailed Performance Data & Specs Online at: www.minicircuits.com/amplifier.html



Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001 ISO 14001 CERTIFIED

376 Rev. A

4 x 8 Switch Matrix Serves Smart Antennas

This switch matrix offers the speed, power handling, and reliability needed by smart antenna systems to expand the capacity of cell sites.

Cell-site capacity is a key factor for the economic health of cellular-communications service providers. One of the most promising, though technically difficult, ways to increase capacity (and implement new services) is through the use of "smart" antenna technology, which in its most advanced form, fully adapts to current traffic conditions in each cell. One of the fundamental components in these systems is a

925 to 960 MHz (although other frequencies can be specified) that combines any four transmitter (Tx) inputs each

TOM HOWARD Senior Engineer

KDI Integrated Products, 60 South Jefferson Rd., Whippany, NJ 07981; (973) 887-5700, (973) 887-8100, FAX: (973) 884-0445, e-mail: sales@mckdi-integrated.com, Internet: www.mckdi-integrated.com

switch matrix, such as the model AY-G62S from KDI Integrated Products (Whippany, NJ), that can quickly reconfigure antenna arrays according to signal conditions.

Smart antenna systems use space-division-multiple-access (SDMA) methods to allow more than one user per communications channel. SDMA can also increase cell range by directing energy to a specific geographic area. To support these systems, a switch matrix like the AY-G62S must perform well under all temperature and environmental conditions.

The AY-G62S is a high-power, non-blocking switch matrix for operation from

up to 50 W with any of eight outputs (see table). The matrix employs PIN diode switches and combiners that can handle the total 200 W of average power. The four 50-W inputs pass through double-junction circulators with isolation of about 80 dB to ensure that no power is reflected back to the Tx, while maintaining overall insertion loss at 0.3 dB for this section of the matrix. The signals are then connected to the four 1P8T switches. The circulators and switches are connected with flexible low-loss microwave cables. Reverse isolation from output to any input is 60 dB.

Directional couplers are included in the matrix to allow monitoring of forward and reflected power at each antenna output. The unit measures 14.57 × 9.80 × 2.13 in. (37.008 × 24.9 × 5.4 cm) and weighs 20 lb. (9 kg). A wide variety of configurations can be provided in wireless bands through 2.6 GHz. MCE/KDI-Integrated Products, 60 S. Jefferson Rd., Whippany, NJ 07981; (973) 887-5700, FAX: (973) 884-0445, e-mail: sales@mckdi-integrated.com, Internet: www.mckdi-integrated.com.

The AY-G62S at a glance

Frequency range (MHz)	925 to 960*
Maximum input power (dBm)	47
Input/output return loss (dB, min.)	14
RF to bias filtering (dB, min.)	50
Maximum insertion loss (dB)	8.2
Isolation (dB, min.)	
Between any two points	83
Reverse transmit out to transmit in	60
Input to "off" output	30
Transmit to "off" output	30
Intermodulation distortion (dBc, four 50-W inputs)	90

*Other frequency ranges are available.

WORLD'S SMALLEST DIRECTIONAL COUPLERS

9 to 20dB... Immediate Delivery



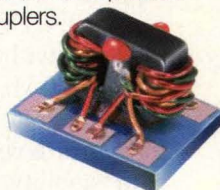
\$1.99
only each (qty. 25)

The DBTC series from Mini-Circuits is quite simply the smallest, **lowest priced** 5 to 2000MHz directional coupler series on Earth! Available in 9 to 20dB nominal coupling values, these patented 50&75 ohm couplers integrate Blue Cell™ design techniques for **very flat coupling**, low insertion loss, and multi-decade **broad bandwidths**. All-welded connections improve reliability, and automated production delivers high unit-to-unit performance repeatability. Plus, Mini-Circuits low price of only \$1.99 each (qty. 25) gets even lower with higher quantities! So, preserve precious board space, and capital as well. Specify Mini-Circuits DBTC directional couplers.

CUSTOM PRODUCT NEEDS...Let Our Experience Work For You.



Protected by U.S. Patent 6140887. Additional patents pending.



DBTC SPECIFICATIONS

Coupling	Model	Freq. (MHz)	Ins. Loss (dB) Midband Typ	Directivity (dB) Midband Typ
9dB	DBTC-9-4	5-1000	1.2	18
10dB	DBTC-10-4-75	5-1000	1.4	20
12dB	DBTC-12-4	5-1000	0.7	21
13dB	DBTC-13-4	5-1000	0.7	18
13dB	DBTC-13-5-75	5-1000	1.0	19
		1000-1500	1.4	17
16dB	DBTC-16-5-75	5-1000	1.0	21
		1000-1500	1.3	19
17dB	DBTC-17-5	50-1000	0.9	20
		1000-1500	1.0	20
		1500-2000	1.1	14
18dB	DBTC-18-4-75	5-1000	0.8	21
20dB	DBTC-20-4	20-1000	0.4	21

Dimensions 0.15" square.

DESIGNER'S KITS

K1-DBTC (50 Ohms) 5 of ea. DBTC-9-4, 12-4, 13-4, 17-5, 20-4.

Total 25 Units \$49.95

K2-DBTC (75 Ohms) 5 of ea. DBTC-10-4-75, 13-5-75, 16-5-75, 18-4-75. Total 20 Units \$39.95

For detailed specs visit: www.minicircuits.com/dcoupler.html

We're redefining what VALUE is all about!

Mini-Circuits®

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661 For quick access to product information see MINI-CIRCUITS CATALOG & WEB SITE



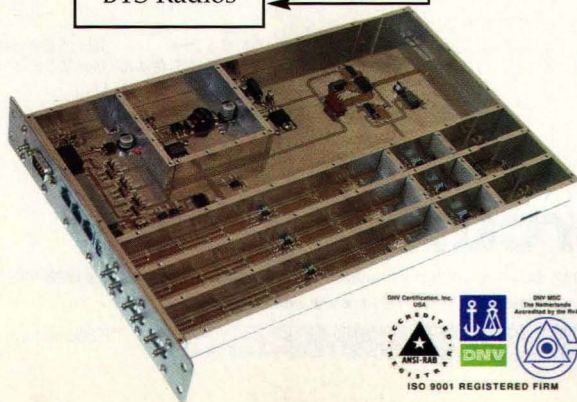
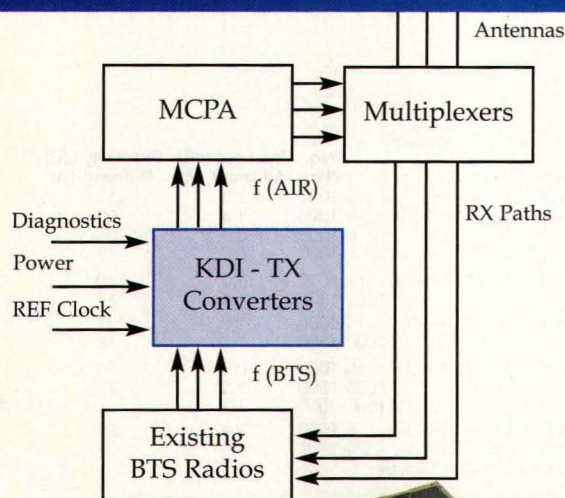
The Design Engineers Search Engine Provides ACTUAL Data Instantly From MINI-CIRCUITS At: www.minicircuits.com

ISO 9001 CERTIFIED

F 366 rev org.

MCE**KDI-INTEGRATED PRODUCTS**

How often do you hear “the Lab is working on it?”



Tired of waiting for your Lab? You don't have to when you work with KDI's Advanced Engineering Design Lab. Which means you will be getting a custom integrated solution fast, and ready for production.

Our new BTS Transmitter Converters are a prime example. In a matter of weeks from concept to production Transmitter Converters enable new base station frequencies that are derived from existing radios and BTS equipment. Minimum changes are needed to existing designs to bring new base stations to market very quickly, at low cost.

MCE-KDI Transmitter Converters scale frequencies Up or Down with critical rf path signal quality, from Cellular to PCS or 450 MHz, in any wireless modulation protocol. From KDI Integrated products you can expect the highest performance level of Intermodulation/linearity, gain flatness, gain stability, spurious outputs, phase linearity / group delay, internal diagnostics and microprocessor function with proven field reliability. You can count on KDI for your custom integrated solution, from the Lab to production quickly!

MCE**KDI-INTEGRATED PRODUCTS**

60 South Jefferson Road, Whippany, NJ 07981 • Tel: 973-887-8100 • Fax: 973-884-04
Web site: www.mcekd-integrated.com • e-mail: sales@mcekd-integrated.com

The Difference Starts With The Cable

LOW ATTENUATION (LA)

MADE-TO-ORDER INTERCONNECT ASSEMBLIES

High Performance: 20 dB/100 ft @ 18 GHz

Finally, microwave frequency interconnect cable assemblies are available at a competitive price!

When you need dependable low loss performance in a longer length interconnect, LA custom cable assemblies are just the ticket. What makes these assemblies such a remarkable value is the performance advantage of Semflex's own double-shielded LA cable, matched to superior connectors, then precision assembled and tested.

Beyond the high quality components, every assembly is fully designed and manufactured by Semflex from the ground up. Which means you can count on fully matched construction, responsive customer service, and technical support when you need it.

Take a look at the specs, then call Sandy at **800-778-4401** to schedule an on-site visit by one of our factory experts.

SPECIFICATIONS

Low Attenuation	20 dB/100ft @ 18 GHz
Phase Stable	
Phase vs Flexure	$< .0003 \times \text{freq (GHz)} \times \text{bend angle (deg)}$
Phase vs Temp	$< \pm 500 \text{ PPM from } -55^{\circ} \text{ to } +75^{\circ} \text{ C}$
Low Leakage	$< 100 \text{ dB/ft @ 18 GHz}$
Temperature Range	$65^{\circ} \text{ to } +200^{\circ} \text{ C}$
Cable Dimension	.290"
Connectors	SMA, N, extended range TNC
Standards	MIL-C-39012, MIL-STD-348A and other applicable industry specs

Need it FAST? Call Semflex!

Semflex provides the quickest delivery in the industry. Ship Same Day* – on over 180 standard products. Ship Within 48 Hours* – on made-to-order assemblies with COTS components.

*When ordered before noon (PST)

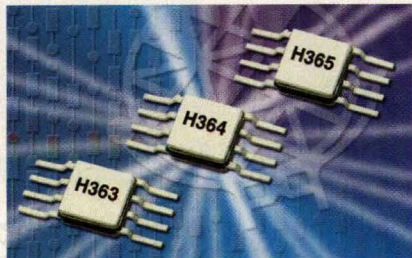
Call 800-778-4401 or Visit www.semflex.com

Visit us at the Wireless Systems Design Show, Feb. 24-27 in San Jose, CA. Booth #626-630

Semflex
MADE IN U.S.A.
ISO 9001

Hermetic SMT Frequency Dividers Cover DC To 13 GHz

A FAMILY OF HERMETIC SMT packaged GaAs HBT MMIC frequency dividers for hi-rel commercial, military, and aerospace PLL applications has been released. The HMC364G8,



HMC365G8, and HMC363G8 prescalers offer divide ratios of 2, 4, 8 respectively in 8-lead hermetic SMT packages. Both the HMC364G8 and HMC365G8 operate from DC to 13 GHz input frequency while the HMC363G8 operates from DC to 12 GHz. The low additive 100-kHz SSB phase noise ranges from -145 dBc/Hz for the HMC364G8 to -153 dBc/Hz for the HMC363G8. All of these products operate from a single +5-VDC supply. P&A: Sample and production quantities are available. **Hittite Microwave Corp., 12 Elizabeth Dr., Chelmsford, MA 01824; (978) 250-3373, FAX: (978) 250-3373, Internet: www.hittite.com.**

Library Aids In The Prediction Of Performance

LICENSES ARE NOW BEING provided for the MDLX Select™ Library. Licenses for the initial release, compatible with Agilent's ADS electronic-design-automation (EDA) platform, will be provided at no cost. The initial MDLX Select Library comprises substrate-scalable Global Models™ that predict the performance of surface-mount RLCs over the entire parts-value range of a given family. Component performance variations with mounting are predicted over a wide range of substrate properties. **Modelithics, Inc., 13101 Telecom Dr.,**

Suite 105, Tampa, FL 33637-0914; (813) 866-6335, FAX: (813) 558-1102, e-mail: sales@modelithics.com, Internet: www.modelithics.com.

Phase-Locked Sources Offer Suitable Phase Noise

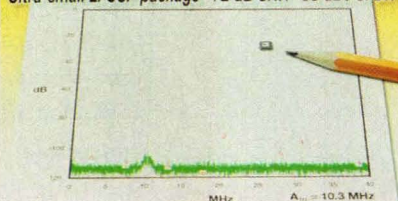
THE BCO SERIES phase-locked sources offer low phase and spurious noise in a $2.25 \times 2.25 \times 0.55$ -in. ($5.715 \times 5.715 \times 1.397$ -cm) package. Available from 500 MHz to 14 GHz, the sources operate from either an external reference or internal TXXO with stability as low as 1 PPM.

MITEQ, Inc., 100 Davids Dr., Hauppauge, NY 11788; (631) 436-7400, FAX: (631) 436-7430, Internet: www.miteq.com.

ADC Features sub-500-mW Power Consumption

THE INDUSTRY'S FIRST 3-V, 14-b, 80-MSPS analog-to-digital converter (ADC) to feature sub-500-mW power consumption, model AD9245 is suitable for pico-cell and micro-cell designs with multiple base stations on one tower. The AD9245 operates with a signal-to-noise ratio (SNR) of 72 dB and spurious-free dynamic range (SFDR) of 85 dBc. It is pin compatible with the AD9235 12-b,

AD9245 14-bit 80 MSPS, 3 V ADC
Ultra-small LFCSP package • 72 dB SNR • 85 dBc SFDR



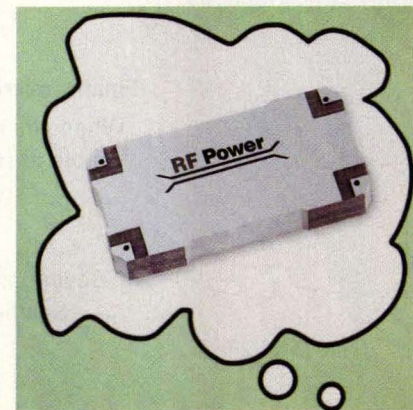
20-/40-/65-MSPS ADC, AD9236 12-b, 80-MSPS ADC, and AD9215 10-b, 65-/80-/105-MSPS ADC. The sample-and-hold amplifier (SHA) can be configured for single-ended or differential operation. P&A: The AD9245 is packaged in a 32-pin CSP and is priced at \$38.00 per unit in 1000-piece quantities.

Analog Devices, Inc., 804 Woburn St.,

Wilmington, MA 01887; (800) 262-5643, FAX: (781) 937-1021, Internet: www.analog.com.

Couplers Are Specialized For UHF Applications

A LINE-UP OF HYBRID couplers is suited for high-power UHF applications; couplers are also available for AMPS, GSM, DCS, PCS, and 3G systems. A multilayer, stripline SM component available on tape and reel for automation-based assembly—this 3-dB hybrid coupler measures 1.0×0.5 in. (25.4×12.7 mm) and handles power up



to 300 W with low insertion of less than 0.15 dB. Other specifications include amplitude balance of ± 0.6 dB, phase balance of ± 2 deg., and isolation greater than 18 dB.

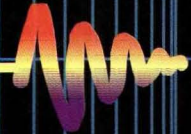
Anaren Microwave, Inc., 6635 Kirkville Rd., East Syracuse, NY 13057; (315) 432-8909, FAX: (315) 432-9121, Internet: www.anaren.com.

Miniature SMA Couplers Save Real Estate

THE 780 SERIES OF miniature, 50-W, stripline directional couplers are suitable for applications between 500 MHz and 18 GHz. The directional couplers are available with standard nominal coupling values of 10, 20, and 30 dB.

MECA Electronics, 459 East Main St., Denville, NJ 07834; (973) 625-0661, e-mail: sales@e-meca.com, Internet: www.e-meca.com.

Times Microwave Systems Tech Center



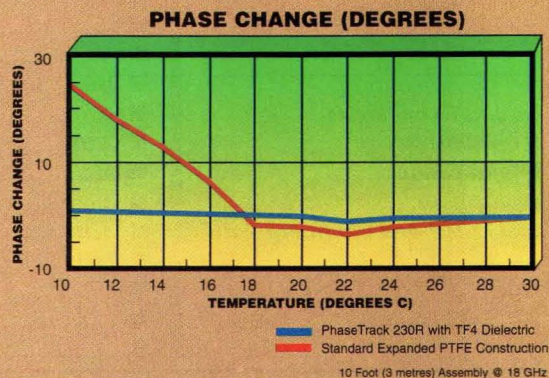
PhaseTrack™

Ultra Phase Stable Test Cable and Assemblies

PhaseTrack™ Test Cables provide unmatched phase stability and tracking performance over a wide temperature range — providing significantly improved measurement accuracy and repeatability not previously available. These advanced technology test cables utilize the proprietary Times Microwave Systems TF4™ dielectric, which has unique thermal stability properties. This results in significantly less phase change over temperature performance than any other solid or "high performance" expanded PTFE dielectric cable types available anywhere today. By using PhaseTrack™ cables with your Vector Network Analyzer, you can be sure of excellent retention for test equipment calibration, even when the temperature of the testing environment changes over a very wide range. Our sales engineers can help you to specify the best product for your application.

Features & Benefits:

- Minimal Phase Change over Temperature
- Superior Phase Stability with Bending
- Operates to 18 GHz
- Field Interchangeable Connectors
- High Performance TNC, N, SMA, 7mm and 7/16 DIN Connectors Available
- Long Term Electrical Stability
- Rugged Construction

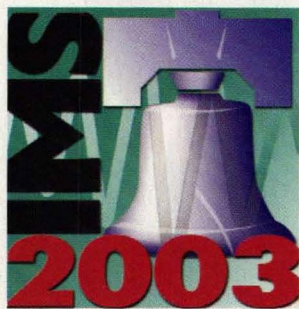


Applications:

- Test Laboratories
- Field Test and Verification
- Military Systems Interconnect Use
- Upgrade or Replacement of Damaged or Obsolete Microwave/RF Test Cables
- Quality and Maintenance Test Programs

Times Microwave Systems is the leader in the development of RF and Microwave interconnect solutions for military, wireless, precision testing and other applications. To keep up to date on our latest developments look for additional Tech Center releases .

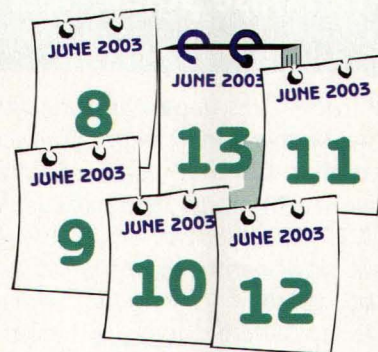




IEEE
Microwave Theory and Techniques Society
International Microwave Symposium
Philadelphia, PA
June 8–13, 2003

**MARK YOUR CALENDAR NOW
TO ATTEND THE**

**2003 IEEE MTT-S International
Microwave Symposium & Exhibition
June 8–13, 2003
Pennsylvania Convention Center**



**Featuring Technical Sessions and Workshops
for Wireless, Commercial and Military Applications**

- | | |
|----------------------------------------------------------------|------------------------------------------------|
| ■ ICs for Wireless Communications | ■ Nonlinear Modeling and Analysis |
| ■ Microwave Vehicular Technology | ■ Measurement Theory and Techniques |
| ■ CAD Design Methodology | ■ High Power Sources and Control |
| ■ Power Devices and MMICs | ■ Low Noise Receivers |
| ■ Wireless Communication Systems and Technologies | ■ Manufacturing, Production and Packaging |
| ■ Power Amplifiers for Wireless Applications | ■ Advances in Hybrid Technology |
| ■ Subsystems for Commercial Communications | ■ Millimeter and Submillimeter Wave Technology |
| ■ Biological Effects and Medical Applications | ■ Monolithic Technology |
| ■ Signal Generation, Frequency Conversion and Control Circuits | ■ Active and Quasi-optic Arrays |
| ■ Filters and Multiplexers | ■ Lightwave Technology and Techniques |
| ■ Ferrite Components | ■ Superconductivity Technology |
| ■ Guided Waves and Propagation Characteristics | ■ Microwave Digital Processing |
| ■ Transistor Power Amplification | ■ Full Guest Program — Bring the Family! |

In addition to the outstanding Symposium, visit the World's Largest Microwave Exhibition, featuring more than 400 industry innovators displaying their newest wireless and commercial products and services. Once again this year, industry representatives will be presenting application and marketing seminars which will be open to all attendees.

For information on attending the 2003 IEEE MTT-S International Microwave Symposium, please visit the official show website: www.ims2003.org. Or you may send your postal mailing address to *Microwave Journal* via e-mail, fax or postal mail.

Please contact us at:

e-mail: mwj@mwjournal.com
Fax: 781-769-5037
Post: *Microwave Journal*, 685 Canton St., Norwood, MA 02062

FULL PROGRAMS WILL BE MAILED IN MARCH

SIGNAL GENERATORS

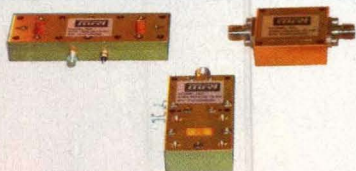


Seven compact, programmable models cover 0.5 to 26.5 GHz with 1 MHz resolution. Prices start at \$4,250

April Instrument
Sunnyvale, CA
www.aprilinstrument.com
Tel: (650) 964-8379 Fax: (650) 965-3711

APRIL INSTRUMENTS

AMPLIFIERS AND MULTIPLIERS 18 TO 100 GHz



STATE OF THE ART PERFORMANCE
18 - 100 GHz

- Power Amplifiers
- Low Noise Amplifiers
- Active Multipliers
- Passive Multipliers

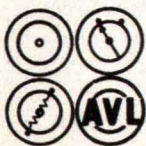


Microwave Resources, Inc.
14250 Central Ave, Suite D Chino, CA 91710
Tel: (909) 627-4125 Fax: (909) 627-4295
www.microwaveresourcesinc.com

MICROWAVE RESOURCES



Aviel Electronics will manufacture standard, custom and difficult-to-locate coaxial connectors conforming to MIL-C-39012 and MIL-STD-348 specifications. Connector sizes range from sub-miniature to type "L" as well as Nano-Hex, SMA, SMB, TNC, MCX, MMCX and 7/16 connectors; as well as non-standard configurations required for specific applications. Specials are quoted with a typical delivery of 6-8 weeks with little or no non-recurring charges.



AVIEL ELECTRONICS
5530 South Valley View Ste. 103
Las Vegas, Nevada 89118
Tel: 702-739-8155
Fax: 702-739-8161
<http://www.engineers.com/aviel/home.htm>

AVIEL ELECTRONICS



Laboratory (RF) MicroProbe Station

Extremely Low Cost
RF/Microwave
Test Environment

A ultra compact, manually operated probe station for engineers, scientists and students. Measure Microwave, RF and IV parameters of Semiconductor Devices. Characterize MEMS, wireless, photonic and nanoelectronic components and assemblies.

- Benchtop Size (<1ft³) • 2" Vacuum chuck • 1" X-Y-Z stage with z-lift
- 2 ea. 0.5" X-Y-Z probe positioners, includes 2 ea. 18 GHz probes
- 10X/30X Stereo Zoom Microscope • Fluorescent Illuminator
- Compatible with additional Magnetic Mount Positioners (optional)
- Compatible with industry standard microwave probes (optional)

Cost effective as a dedicated test station



J microTechnology
3744 NW Bluegrass Pl
Portland, OR 97229
(503) 614-9509
(503) 531-9325 (FAX)
www.jmicrotechnology.com

Research Performance / Student Price

J MICROTECHNOLOGY

SECTOR MICROWAVE INDUSTRIES, INC.

- * DPDT
- * TYPE N, SMA, BNC, TNC
- * MANUAL OVERRIDE
- * DC THROUGH 23 GHz.

(631) 242-2300 FAX (631) 242-8158
www.sectormicrowave.com

SECTOR MICROWAVES, INC.

DeskTop AntennaMeasurement System For Wireless Development



1FT Aluminum & Plastic Ground Plane
Windows Based
20ft 18GHz SMA Cable
Rel. Gain Ref Any
Max signal search/move

Horz Axis
Vert Axis
Standard Tripod

- DC-6, 12 & 18GHz
- 2-Axis Data
- Parallel Port
- De-EmbedSystem
- 20ft. 18GHz
- Cable
- Laser Module
- BiasInjection
- Free Software
- Custom Cables & Gain Slopes
- Group Delay 3-D (O, f)

Download
Demo

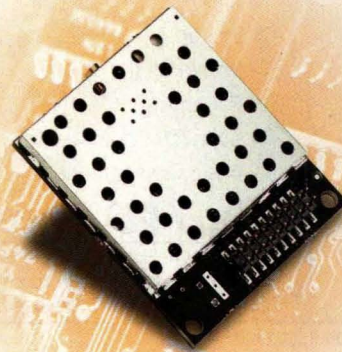
Software Ver 2.0 offers swept freq. at each movement (<) Interfaces with most hp VNA's

Diamond Engineering
484 West 1st, Diamond Springs, CA 95619
(530) 626-3857 www.diamondeng.net
www.MicrowaveRF.com

DIAMOND ENGINEERING

WHAT'S HOT

Products & services that bring fast, simple wireless to OEMs:



Breakthrough 900MHz Radio

AC4490 transceivers provide low cost, long range, secure RF links for local-area applications. The wide variety of serial modules is interchangeable to comply with international regulations.

- Highest 900MHz data rate: 115.2 Kbps.
- Smallest form factor: 1.65 x 1.9 inches.
- Operates in -40°C to +80°C temp range.
- Variable output power: 5mW to 500mW.
- Less than \$30 in quantities of 10K.

AeroComm, 1-800-492-2320 ext/213.

Download specs online, www.aerocomm.com.

AEROCOMM, INC.



Manual Probe Station

Very Low Cost
High Function
6" or 8" Chuck

A compact full featured, modestly priced, manually operated probe station developed for engineers and scientists. Measure Microwave, RF and DC parameters of Semiconductor Devices, Packages and Assemblies with NIST traceability.

- Benchtop Size (<3ft³) • Vacuum chuck • Slide out X-Y-Z stage
- X-Y-Z probe positioners • Top Plate Z-lift • Vacuum Accessory Manifold
- 6.5X-112.5X Stereo Zoom Microscope • Adjustable Halogen Illuminator
- Vacuum Accessories • Compatible with 40GHz+ probes
- Accessories for Thermal Chucks and Probe Cards
- Compatible with Magnetic Mount Positioners

Test wafers, microstrip packages and surface mount components

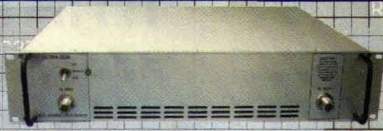


J microTechnology
3744 NW Bluegrass Pl
Portland, OR 97229
(503) 614-9509
(503) 531-9325 (FAX)
www.jmicrotechnology.com

A Precision Probe Station at a Utility Price

J MICROTECHNOLOGY

LINEAR RF



BROADBAND RF:

- ▶ Linear
- ▶ Broadband
- ▶ Reliable
- ▶ Cost Effective
- ▶ Basic Convenience

- LA Series - Linear Amplifier
- Up to 1 GHz
- Up to 300 Watts
- New Design Solutions

T&C Power Conversion, Inc.
110 Halstead Street #7 Phone: 1-585-482-5551
Rochester, New York 14610 USA Fax: 1-585-482-8487
<http://www.tcpowerconversion.com>

T & C POWER CONVERSION



"Where your dreams turn into reality."

- OCXO up to 400 MHz
- WIDE BAND VCXO +/- 5000 ppm pull frequency up to 800 MHz
- Customized crystal and L/C filters
- std. 10.7/21.4/45/70 MHz two pole crystal filters
- Phase noise measurement services

Call / fax for the quote.

Call or Fax your requirements.

16406 N. Cave Creek Rd. #5
Phoenix, AZ 85032-2919
Ph: (602) 971-3301 Fax: (602) 867-7250
Visit our website www.kselectronics.com

K S ELECTRONICS

ANTENNAS

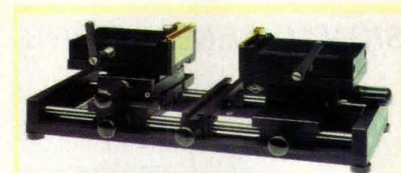


www.antennafactor.com

ANTENNA FACTOR
By LINX

800-489-1634
575 SE ASHLEY PLACE • GRANTS PASS, OR 97526

LINX TECHNOLOGIES



Universal Test Fixture

A compact, modestly priced, manually operated Test Fixture developed for technicians, engineers and scientists.

Measure microwave & RF parameters of circuits, assemblies and semiconductor devices.

- Rugged • Flexible • Repeatable • Measurements to 40 GHz •
- Broadband standard and custom calibration •
- 4-port in-line measurements • Frequency and Time Domain compatible •
- Right angle connector launch option • Accessory platten option •
- Transistor and SMD Test Module Option •
- Test microstrip, CPW and surface mount components •



J microTechnology

3744 NW Bluegrass Pl
Portland, OR 97229
(503) 614-9509
(503) 531-9325 (FAX)
www.jmicrotechnology.com

Precision Microstrip Test with a Utility Fixture

J MICROTECHNOLOGY

Sector Microwave Industries, Inc.



DC to 21.5 GHz. Operation

Space Qualified
Coaxial Switches

(631) 242-2300 FAX (631) 242-8158
www.sectormicrowave.com

SECTOR MICROWAVES, INC.

SP16T Pin-Diode Switch (0.5-18 GHz)



UMCC's Model SR-U010-16S is an absorptive sixteen-throw solid state switch operating over 0.5-18 GHz. Switch features: 7.0 dB loss / 60dB isolation at 18 GHz, 2:1 VSWR, 25ns Rise/Fall time, +5/-12 VDC Supplies, CMOS or TTL controls, all removable connectors. Unit measures 1.6" x 8.0" x 0.4".

Product Line:

- Solid State Variable Attenuators
- DC-Blocks, Bias Tee's, Transformers
- Directional Couplers
- Hybrid Couplers (90°/180°)
- Power Dividers / Combiners
- Solid State Switches
- Special Function Subsystems

Universal Microwave Components Corporation

5702-D General Washington Drive
Alexandria, Virginia 22312
Tel: (703) 642-6332, Fax: (703) 642-2588
Email: UMCC@UMCC111.com
Web: www.umcc111.com



UNIVERSAL MICROWAVE

RETURN LOSS BRIDGES



TYPES: Fixed and Variable Bridges

FREQUENCY RANGES:

Models available from .03 - 1000 MHz

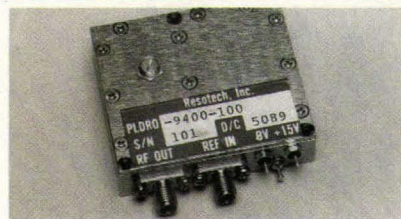
DIRECTIVITY: 40 dB minimum

WBE Bridges are Broadband RF transformer type RF In-RF Out Impedance Bridges. Insertion loss of the bridge is read directly as return loss (VSWR).a Options include impedance conversion (i.e. for taking 75 ohm measurements on a 50 ohm system), DC blocking, Test Data, and connectors.

WIDE BAND ENGINEERING CO. INC.

P.O. Box 21652, Phoenix, AZ 85036
Phone & Fax (602) 254-1570
Web Site: <http://www.wbecoinc.com>

WIDE BAND ENGINEERING



COMPACT DROs AND PHASE LOCKED DROs OPERATE AT FREQUENCIES FROM 3.3 TO 14 GHz OVER -54 TO +85°C

Mechanical tuning range 4%

Power output +15 dBm min.

Reference input frequency 10-150 MHz

Power Supply: +12 or +15 ± 1VDC @ 75mA

RESOTECH ALSO OFFERS FERRITE CIRCUITORS AND ISOLATORS FROM 50 MHz TO 100 GHz

RESOTECH, INC.

13610 N. Scottsdale Rd., #10-233
Scottsdale, AZ 85254

Tel: (480) 483-8400 Fax: (480) 483-2504

www.resotechinc.com

RESOTECH, INC.

TO ADVERTISE, CALL
JOANNE REPPAS
(201) 666-6698

ProCAP Nodal Analysis

REDUCED PRICE



\$595

Tune & Optimization
Noise Analysis & Noise Circles
Transmission Line Analysis
Multiple Coupled Lines
Monte Carlo Sensitivity
Equation
L-C Filter Design
Match

WaveCON Tel: (760) 747-6922
Website: www.waveconsoft.com

WAVECON

MICROWAVES & RF ENGINEERING CAREERS

CAREER OPPORTUNITIES NATIONWIDE

EXPERIENCED AND DEGREEED ENGINEERS FOR TOP DEFENSE AND COMMERCIAL COMPANIES. EXPERIENCE IN ALL OR SOME OF THE FOLLOWING DISCIPLINES NEEDED FROM ENGINEERING-LEVEL TO VP LEVEL: OSCILLATORS/MULTIPLEXERS/TRANSCIEVERS/RECEIVERS/ SYNTHESIZERS/RF/MICROWAVE-HARD ENGINEERING/ MARKETING/BUS DEV/ENGINEERING
E-MAIL RESUME TO: pma820@yahoo.com.

RATES

Effective January 1, 2003
\$225 per column inch
Commissionable to agencies

DEADLINES

Space reservation:
5th of month preceding issue date
Ad material to:
Penton Media Inc., Classified Dept.
45 Eisenhower Dr., fifth floor
Paramus, NJ 07652

SALES STAFF

JoAnne Reppas
(201) 666-6698
Fax: (201) 666-0557
e-mail: jrepfrangides@msn.com

Advertiser	Website, E-Mail Address	Page
A		
Aerocomm Inc.	www.aerocomm.com	109
Alk Engineering	www.alkeng.com	58
Anritsu Company	www.us.anritsusc.com/family/126	Cov 2
Ansoft Corporation	www.ansoft.com/ansoftdesigner	26, 27, 91
Anaren Microwave Inc.	www.anaren.com	Cov 4
Antenna Factor	www.antennafactor.com	110
April Instruments	www.aprilinstrument.com	109
Applied Wave Research	www.mwofice.com	12
AR Kalmus Corporation	www.arkalmus.com	74
Arra Inc.	www.arra.com ; e-mail: sales@arra.com	Cov 3
Avtech Electrosystems Ltd.	www.avtechpulse.com ; e-mail: info@avtechpulse.com	18
Aviel Electronics	www.engineers.com/aviel/home.htm	109
C		
California Eastern Lab	www.cel.com/switches.asp	4
Cap Wireless Inc.	www.capwireless.com	66
Ciao Wireless Inc.	www.CiaoWireless.com ; e-mail: Sales@CiaoWireless.com	68
Coilcraft	www.coilcraft.com	10
Compac	www.compac-rf.com	58
Computer Simulation Technology	www.cst-world.com	50
Communications Techniques	www.cti-inc.com ; e-mail: sales@cti-inc.com	97
D		
DBM, LLC	www.dbmcorp.com	86
Diamond Engineering	www.MicrowaveRF.com	109
Digi-Key	www.digikey.com	3
E		
Eagleware	www.eagleware.com ; e-mail: sales@eagleware.com	45
G		
Greenray Industries Inc.	www.greenrayindustries.com ; e-mail: sales@greenrayindustries.com	56
H		
Herley Industries	www.herley.com ; e-mail: sales@generalmicrowave.com	40
Herotek Inc.	www.herotek.com ; e-mail: info@herotek.com	44
Hittite Microwave	www.hittite.com	55, 57, 59, 61, 63
Huber & Suhner, Inc.	www.hubersuhner.com	67
I		
Interad Ltd.	e-mail: interad@interadltd.com	18
ITT Industries	www.ittmicrowave.com	19
J		
JCA Technology	www.jcatech.com ; e-mail: jca@jcatech.com	2
JFW Industries Inc.	www.jfwindustries.com ; e-mail: sales@jfwindustries.com	54
J Microtechnology	www.jmicrotechnology.com	109, 110
K		
K&L Microwave/Dover	www.klmicrowave.com	6
K S Electronics	www.kselectronics.com	110
L		
Linear Technology Corporation	www.linear.com	99
Lucix Corporation	www.lucix.com	36
M		
Maxim Integrated Products	www.maxim-ic.com/radio	73
Maury Microwave Inc.	www.maurymw.com	37
MCE KDI Integrated Products	www.mcekd.com	104
MCE Inmet Corp.	www.inmetcorp.com	8
MCE Weinschel Corporation	www.weinschel.com ; e-mail: sales@weinschel.com	7
Merrimac Industries Inc.	www.merrimacind.com	85
Mid-Atlantic RF Systems Inc.	www.midatlanticrf.com	17
Mimix Broadband	www.mimixbroadband.com	42
Mini-Circuits/SCI Components	www.minicircuits.com	14-15, 16, 29, 30-31, 35, 47, 49, 53
Mini-Circuits/SCI Components	www.minicircuits.com	77, 79, 83, 87, 93, 95, 101, 103
Micro-Coax Components	www.micro-coax.com	32
Microwave Journal	www.mwjjournal.com ; e-mail: sales@mwjournal.com	108
Midwest Microwave	www.midwest-microwave.com ; e-mail: sales@midwest-microwave.com	22
Microwave Resources Inc.	www.microwaveresourcesinc.com	109
Miteq Media	www.miteq.com	1, 11, 81
N		
Nemal Electronics Intl Inc.	www.nemal.com ; e-mail: info@nemal.com	112
Nuhertz Technologies, LLC	www.filter-solutions.com	60
P		
Palomar Technologies	www.palomartechologies.com	96
Philips Semiconductors	www.semiconductorsphilips.com/wireless	9
Precision Photo-Fab	www.precisionphotofab.com	36
Pulsar Microwave Corp.	www.pulsarmicrowave.com	78
R		
Resotech, Inc.	www.resotechinc.com	110
RFHIC Company	www.rfhic.com ; e-mail: sales@rfhic.com	34
RF Micro Devices	www.rfmd.com	69, 71
S		
Sawtek Inc.	www.sawtek.com ; e-mail: info@sawtek.com	89
Semflex Inc.	www.semflex.com	105
Sector Microwave Ind Inc.	www.sectormicrowave.com	109, 110
Spectrum Elektrotechnik GmbH	www.spectrum-et.com ; e-mail: specielek@CompuServe.com	23
Sprague-Goodman Electronics	www.spraguegoodman.com	62
Spinner North America	www.spinnerna.com ; e-mail: sales@spinnerna.com	100
SSI Cable Corporation	www.ssicable.com	60
Stanford Research Systems	www.thinkSRS.com	88
Synergy Microwave	www.synergymwave.com ; e-mail: sales@synergymwave.com	25, 39, 65
T		
T&C Power Conversion, Inc.	www.tcpowerconversion.com	110
Tekelec Temex	www.temex.net	41
Times Microwave Systems	www.timesmicrowave.com	107
TTE Incorporated	www.tte.com	13
U		
Universal Microwave Components	www.umcc11.com ; e-mail: umcc@umcc11.com	110
V		
Voltronics Corp.	www.VoltronicsCorp.com ; e-mail: info@voltronicscorp.com	90
Voltronics Frequency Control Products Inc	www.voltronicsfcp.com ; e-mail: info@voltronicsfcp.com	98
W		
Wavecon	www.waveconsoft.com	111
Waveline Inc.	e-mail: wavelineinc.com	46
WJ Communications	www.wj.com ; e-mail: sales@wj.com	20
Wide Band Engineering	www.wbecoinc.com	110

*Domestic Edition only **International Edition only This index is provided as an additional service by the publisher, who assumes no responsibility for errors or omissions.

**We Design And
Manufacture To Meet
Your Requirements**
Prototype or Production Quantities

800-522-2253

**This Number May Not
Save Your Life...**

But it could make it a lot easier!
Especially when it comes to ordering
non-standard connectors.

**RF/MICROWAVE CONNECTORS
CABLES & ASSEMBLIES**

Specials our specialty. Virtually any
SMA, N, TNC, BNC, SMB, or SMC
delivered in 2-4 weeks.

Connectors supplied to
your drawings and specs.

Extensive inventory of passive RF/Microwave
components including attenuators,
terminations and dividers.

NEMAL ELECTRONICS INTERNATIONAL, INC.
12240 NE 14 AVENUE • NORTH MIAMI, FL 33161
TEL: 305-899-0900 • FAX: 305-895-8178
BRASIL: (011) 5535-2368
E-MAIL: INFO@NEMAL.COM
URL: WWW.NEMAL.COM



**Need Help With
Big Microwaves
Design Projects?**

Your gateway site to

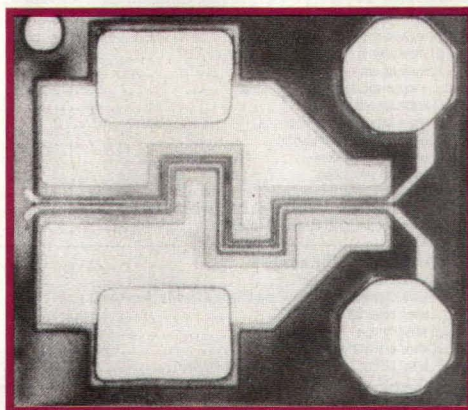


Penton Electronics Group

Microwaves & RF

www.mwrf.com

—looking back—



JUST OVER 19 YEARS AGO, Motorola's Semiconductor
Products Sector ventured into the world of GaAs transistors
with the short-lived model MRF966 dual-gate GaAs FET.

→next month

Microwaves & RF May Editorial Preview Issue Theme: MTT-S Preview/ Radar & Antennas

News

One of the microwave industry's major events, the IEEE Microwave Theory & Techniques (MTT-S) is scheduled for June 8-13, 2003 in the Philadelphia Convention Center (Philadelphia, PA). Before deciding to make the trip, however, don't miss the industry's most concise and insightful preview of this year's MTT-S, with highlights of the regular technical sessions, panel sessions, workshops, and the RF Integrated Circuit (RFIC) Symposium technical sessions. In addition, this special preview section will also take note of the MTT-S exhibitors and a sampling of key product introductions scheduled for the MTT-S. Get a glimpse at the show in the May issue of *Microwaves & RF*.

will offer guidelines for configuring an optimal RF/microwave switching system, while an author from Anritsu Co. will show how to apply complex burst signals to measurements performed on single-carrier and multicarrier power amplifiers for cellular base stations.

Product Technology

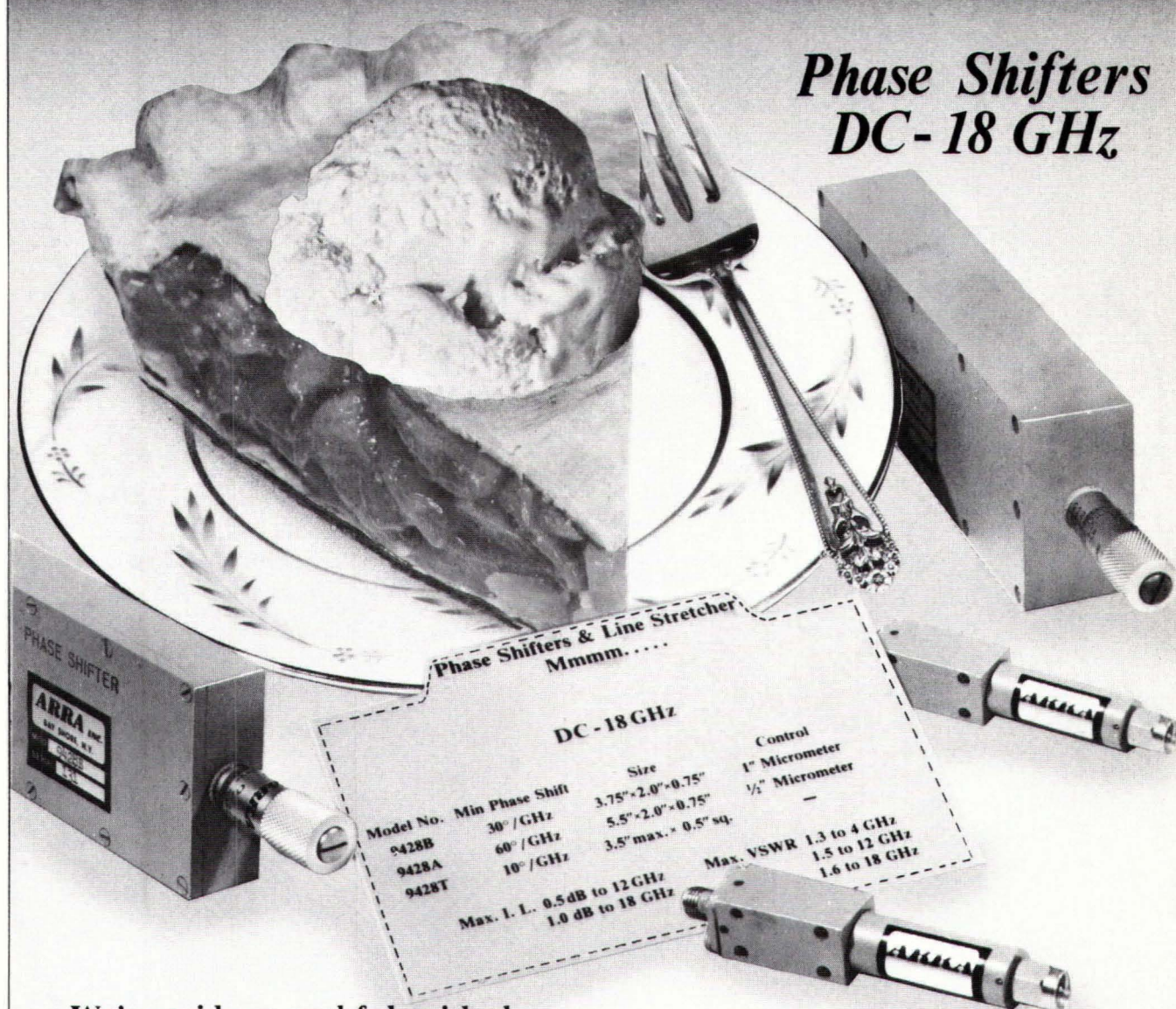
In May, the Product Technology section will highlight a pair of chips that team to handle all three major wireless-local-area-network (WLAN) standards: IEEE 802.11a, b, and g. Not only does this chip set provide ease of installation for next-generation WLAN product designers, but it does so with superb RF and baseband performance at a fraction of the power consumption of competing solutions. Additional Product Features in May will offer a second look at an innovative analog linearizer that increases power-amplifier efficiency and linearity, a blind-mate connector system with a new approach, a set of millimeter-wave amplifiers based on novel spatial-combining techniques, and a high-performance test set that speeds and simplifies measurements of radar pulse stability.

Design Features

May's Design Feature section will cover numerous techniques that may prove useful in the design and analysis of both radar and communications systems. Authors from Atmel, for example, will explore what happens to a high-speed digital pulse when traveling along a length of coaxial cable. In addition, authors from Keithley Instruments

Get a piece of the ARRA pie...

Phase Shifters DC - 18 GHz



We've said a mouthful with these pie à la mode units . . . A truly time-tested ARRA product. Modified along the way into a lightweight rugged, dependable product. Practically shockproof (can stand up to any environmental). *Broadband, linear phase slope, great specs!*

- Three sized units for maximum, medium, or trim-type phase adjustments
- Low insertion loss & excellent VSWR
- Completely enclosed sliding mechanism offers maximum protection

Visit our website at www.arra.com

E-Mail: sales@arra.com

- Available with micrometer or locked shaft
- Unique matching structure
- RF power, 100 W average

Some of the best darn component recipes you can find are cooking at ARRA right now! Send for your copy today and get a piece of the ARRA pie.

... the last word in variable attenuators

ARRA INC.

15 Harold Court • Bay Shore NY 11706-2296

Tel 631-231-8400

Fax 631-434-1116



Let the industry's lowest-cost, highest-performing transformers transform your cell phone, wireless-LAN chipset, or Bluetooth™ design.

Anaren innovation strikes again — with our new family of Femto-sized Xinger®-brand transformers! Perfect for next-gen 802.11 wireless chipsets, handhelds, and Bluetooth™ platforms — Anaren FBs replace ceramic and Lumped Element printed circuit-board baluns for monster performance and price gains.

- As small as 0.120 x 0.120 x 0.035" (3.05 x 3.05 x 0.89 mm)
- Low 0.5dB insertion loss and market-leading phase & amplitude balance vastly improve power consumption, noise figures, dynamic range
- Class-leading return loss makes FBs mis-match tolerant
- Available in tape/reel
- Available in 50-50Ω (100Ω Balanced)
- Choose from 2.4-2.5 GHz and 5.15-5.35 GHz

To learn more, call for a quick-quote — or email pbfb@anaren.com

NEW!



With our new, specifically matched 100W terminations — Xinger®-brand circulators make even more sense!

The new, RF Power-brand, 100 W surface-mountable termination delivers what you've really been looking for: a completely surface-mountable termination that eliminates a manufacturing step — and cuts assembly time and labor costs!

- Family of five alumina terminations, specifically matched to each Xinger-brand circulator
- Each unit measures only 0.5 x 0.5 x 0.06" (12.7 x 12.7 x 1.5 mm)
- Available for AMPS, GSM, DCS, PCS, and UMTS bands
- 50Ω resistance, with 2% tolerance
- Each and every RF Power-brand component arrives 100% tested, for guaranteed, reliable performance
- Less than a \$1.50 in high volume!

Call for a quick-quote — or e-mail 100Wterms@anaren.com.

NEW!



We developed these babies for anyone using 450MHz to develop a big, new market.

Bringing wireless services to a large, not well-infra-structured geographical region? Make sure Anaren's 450 MHz Xinger®-brand, SMT couplers are "on board":

- 90° Hybrid coupler (Part #11303-3)
 - Low profile unit, measures 0.65 x 0.48 x 0.07" (15.51 x 12.2 x 1.85 mm)
 - Low loss of 0.35 dB/max
 - High isolation with 20 dB/min
 - Ideal for splitting & combining, particularly in high-power amps
 - 380-520 MHz, with narrowband 450-470 MHz specs
- Directional coupler (Part #1103-20)
 - Low profile unit, measures 0.65 x 0.48 x 0.073" (16.51 x 12.2 x 1.85 mm)
 - Low loss of 0.3 dB/max
 - High directivity of 18 dB/min
 - Ideal for power- and frequency-detecting, and VSWR monitoring in high-power apps
 - 380-520 MHz, with narrowband 450-470 MHz specs

Call for a quick-quote — or e-mail 450MHz@anaren.com



Honey, we shrunk the world's only true SM circulator!

One good innovation deserves another. So, here's an even smaller version of our Xinger®-brand circulator:

- Now available in 1.8, 1.9, and 2.1 GHz
- Time-saving "no touch" assembly
- Ideal for MCPA interstage matching and within repeaters:
 - Size: 0.5 x 0.5 x 0.2" (12.7 x 12.7 x 5.0 mm)
 - Insertion loss: 0.4/0.45 dB/typ max
 - Isolation: 25 dB
 - Return loss: 25 dB
 - Power handling: 20 Watts
- Lead-free finish and lead-free solder compatible

Call for a quick-quote — or e-mail iscirculator@anaren.com.

Anaren®

What'll we think of next?

800-411-6596 > www.anaren.com
In Europe, call 44-2392-232392 > ISO 9001 certified
Visa/MasterCard accepted (except in Europe)

